Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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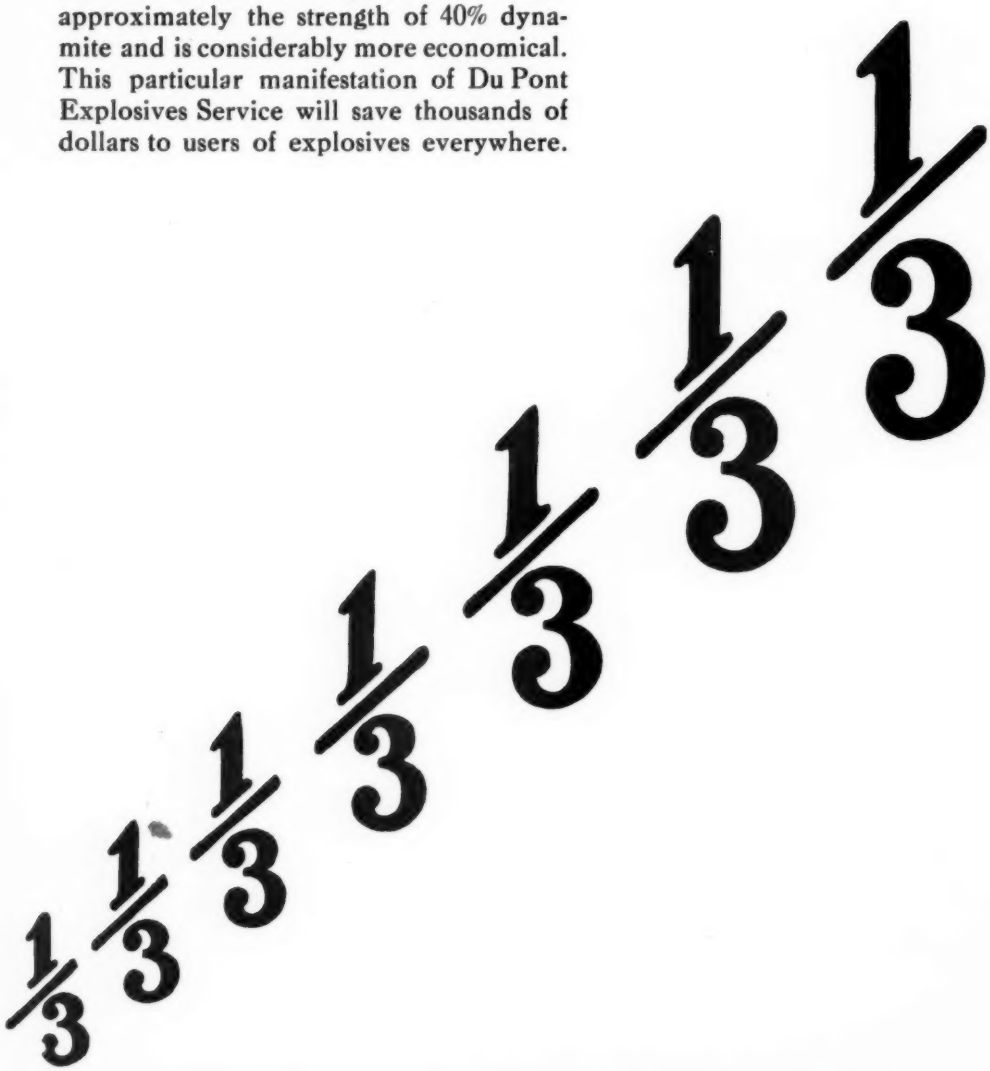

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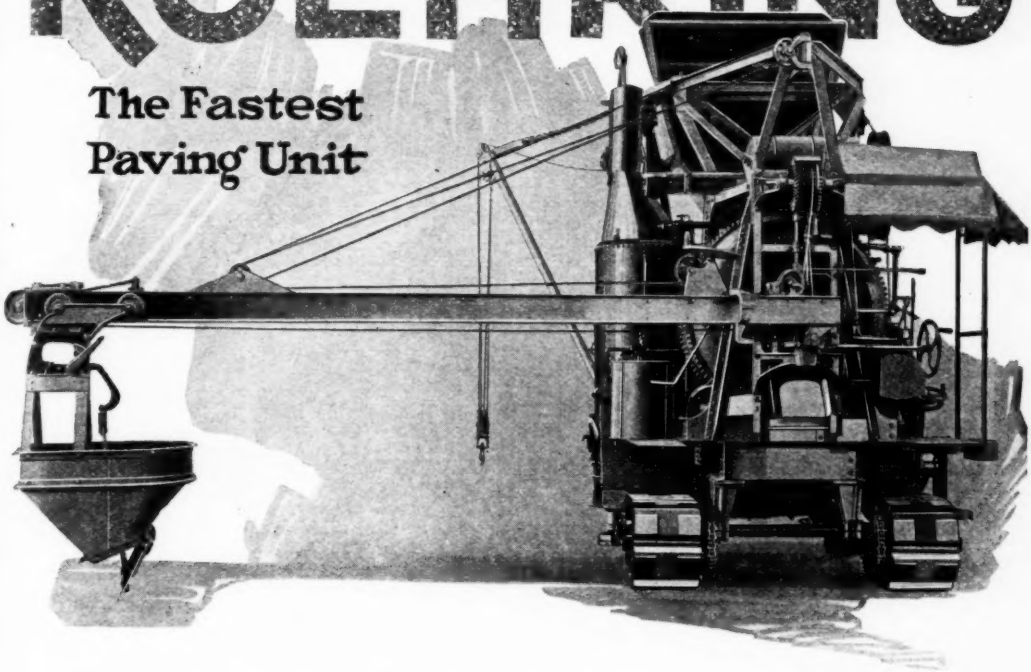

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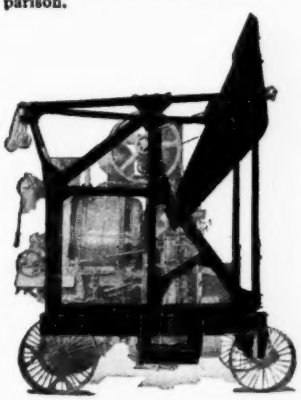

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Width		Depth		Length
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3½"	x	3½"	x	8½"
3½"	x	4 "	x	8½"

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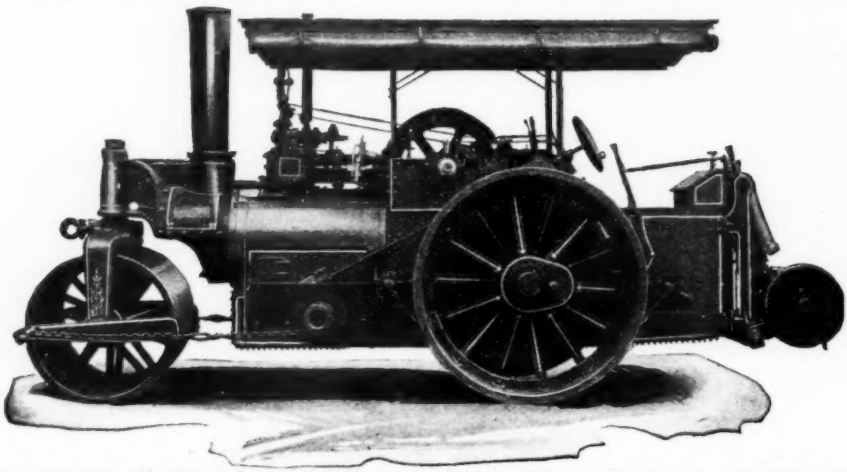

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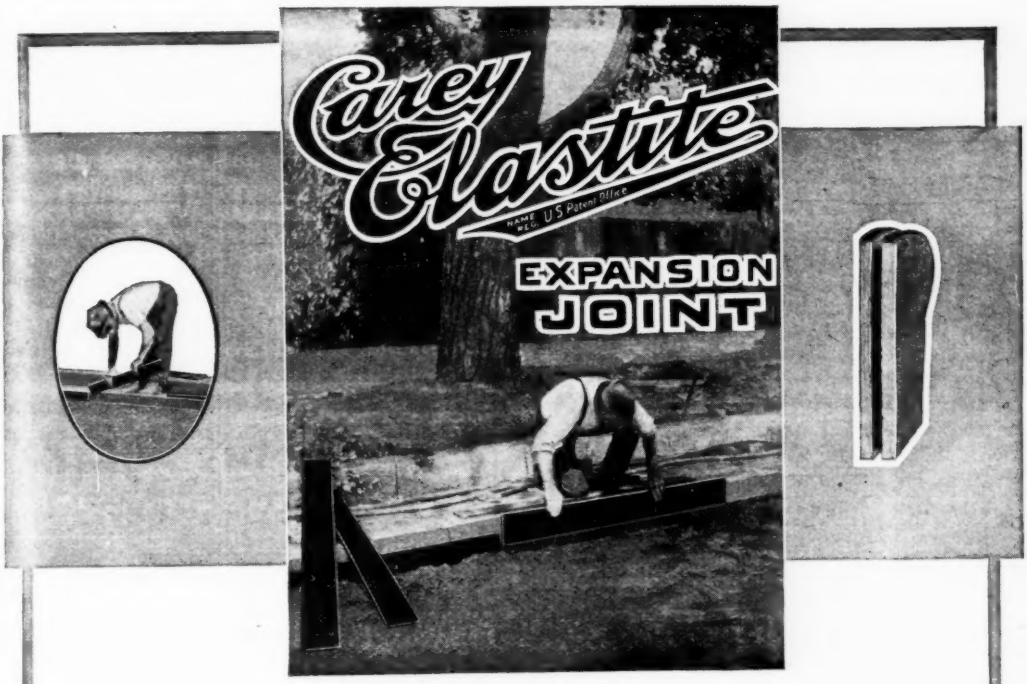

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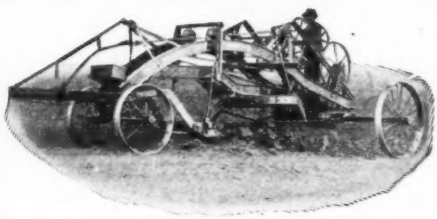

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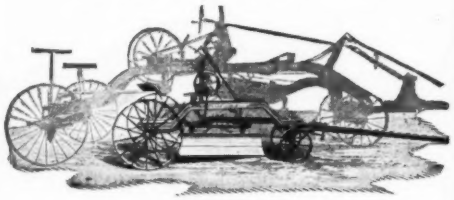

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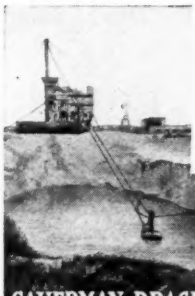

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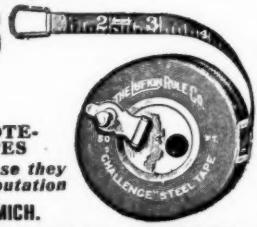

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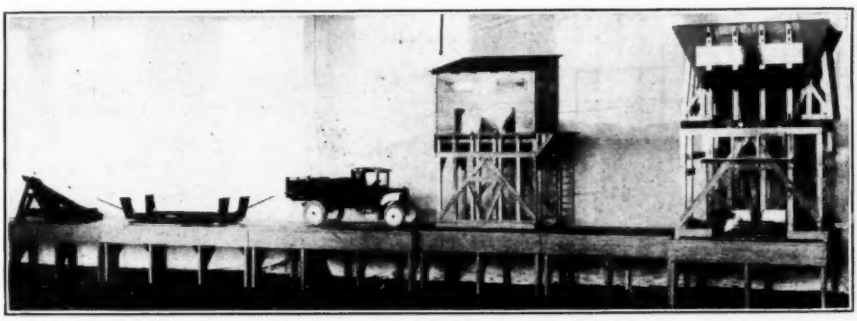

VIEW OF MODELS OF KISSEL ROAD BUILDING EQUIPMENT EXHIBITED AT CHICAGO GOOD ROADS SHOW.

Motor Truck Operation and Accounting—78

METHODS AND COST OF MOTORIZED GARBAGE COLLECTION IN AKRON, OHIO, FOR 1921

By Frank C. Tolles, Superintendent Bureau of Public Works, Delaware Bldg., Akron, Ohio.

The City of Akron, Ohio, during 1921 effected a change in garbage collection methods with data resulting as to performance and to costs. A summary of these is here presented.

Akron has a population estimated at 165,000. It covers an area of 25 square miles and is of varied topography. Of its street mileage but one-third is surfaced.

During previous years garbage has been collected in Studebaker garbage wagons, which centralized to a single transfer station from which the garbage was relayed by 5-ton motor trucks with 10-yd. Lee side dump bodies to the point of disposal—in the present instance, a hog ranch located 9 miles from the loading station.

Following experiments throughout the summer and winter of 1920, there were purchased in 1921, 21 3½-yd. trailers of the Lee side-dump type, and 2 motor tractors—a Mack and a White. The purpose of the change was to lessen unproductive hauling time from collection route to transfer point—an average distance of 2.6 miles. As operated, a team provided with an empty trailer proceeds to the collection district, picks up its load and is then transferred to a second trailer spotted at a prearranged point. The filled trailer is later gathered into a train and drawn to the farm by one of the tractors. Trailers were used throughout the year, but owing to delayed delivery of tractors, were for several months employed solely as wagons.

Partial results of the above are indicated by the tonnage collected per unit of equipment, viz:

TABLE I—GARBAGE COLLECTION, AKRON, OHIO—COLLECTION PER UNIT OF EQUIPMENT.

	Wagon Service Tons per team per day	Trailer Service Tons per team per day
1919—10 mos.	2.14	...
1920	1.82	...
1921	2.21	3.09

The factors of change in effectiveness of labor and of extension of the area served are also represented in Table I. The day referred to is a nominal 8-hour day which represents possibly 6½ hours' working time.

A comparison of collection costs by trailer is given in Table II.

In Table II the various items denoted as Other Charges are prorated to accord with the numbers of trains involved in collection of the tonnages noted, viz:—an average of 8.99 teams per day in wagon service and 7.39 teams per day in trailer service. Miscellaneous labor includes inspection service and otherwise unapportioned labor. Supervision includes clerical help and overhead at the main office as well as the salary of the Superintendent of Collection. Wages varied from

VIEW OF MACK TRACTOR AND LEE TRAILER TRAIN HAULING GARBAGE FOR THE CITY OF AKRON, OHIO.

A Road Sprayer of Proved Dependability

Mack TRUCKS

Capacities 1½ to 7½ tons.
Tractors to 15 tons.

Cressy Road Sprayers are well known the country over as a result of the exceptional service they have been giving for several years. They handle *all* varieties of bituminous road-building material, and their performance with heaviest grades of asphalt is unequalled.

The International Motor Company is the exclusive sales agent for this apparatus which is now installed only on Mack chassis. The sprayer is a complete, independent unit in itself and can be operated without power take-off.

One decided advantage of this apparatus is the fact that the sprayer can be quickly demounted from the Mack chassis and the latter then used with a proper body for general transport service.

We shall be glad to send a booklet to interested parties which describes the Mack-Cressy Road Sprayer.

INTERNATIONAL MOTOR COMPANY
25 Broadway, New York

PERFORMANCE COUNTS

TABLE II—GARBAGE COLLECTION, AKRON, OHIO—COMPARISON OF WAGON AND OF TRAILER COSTS, 1921.

Wagon Collection

312 Days Service: 6,208 Tons.

Teams, $8.99 per day @ $3.55	$ 9,957.32
Wagons, repairs	1,234.79
Harness	1,148.45
Capital charges	1,642.00
Drivers and helpers' wages	28,967.94
Other miscellaneous labor	5,720.00
Charges, small tools	306.00
Power, light, heat	518.00
Miscellaneous sup. and repairs	415.00
Supervision	3,740.00
	$53,649.50

Cost per ton—$8.64.

Trailer Collection.

312 Days Service: 7,138 Tons.

Teams, $7.39 per day @ $3.55	$ 8,185.16
Trailers, repairs	1,038.49
Harness	751.55
Capital charges	6,558.00
Drivers and helpers' wages	24,302.97
Other miscellaneous labor	4,876.48
Charges, small tools	253.09
Power, light and heat	427.64
Miscellaneous sup. and repairs	342.43
Supervision	3,090.00
	$49,825.81

Cost per ton—$6.98.

65 to 80 cents per hour for collectors and from 57 to 65 cents for helpers and reflects reductions effected during the year. The unit team costs are as derived in Table III.

Table IV shows the distribution of expense in operation of the trucks and tractors, delivering garbage. It is self-explanatory.

Summaries from Table II and from Table IV are combined in Table V to give the total cost of collection and delivery.

Truck 67, as reported in Tables IV and V, was used part time to transport garbage and part time as a switch car to spot empty trailers and form trains. Service of the latter nature could be dispensed with at the expense of time required for delivery which locally is kept as low as possible.

Summary

The tractor-trailer method of collection

TABLE III—GARBAGE COLLECTION, AKRON, OHIO—COST OF MAINTAINING TEAMS, 1921.

365 Days—Average Number of Teams, 16.38.

Hay	$3,355.47		
Oats	1,762.50		
Mixed feed	2,259.40		
	$7,377.37	$ 7,377.37	
Straw		810.00	
Barn labor		3,100.00	
Blacksmith—services and supplies		1,868.68	
Veterinary		477.24	
Insurance—liability		305.64	
		$13,938.93	$13,938.93
Horses—capital charges			1,947.00
Land and buildings—capital changes		2,064.10	
Insurance		204.30	
		$2,268.40	2,268.40
Total			$18,154.33

Cost per team per working day, $3.55.

Feed per head per day: Hay, 18.8 lbs.; oats, 10.2 lbs.; mixed feed, 7.3 lbs.

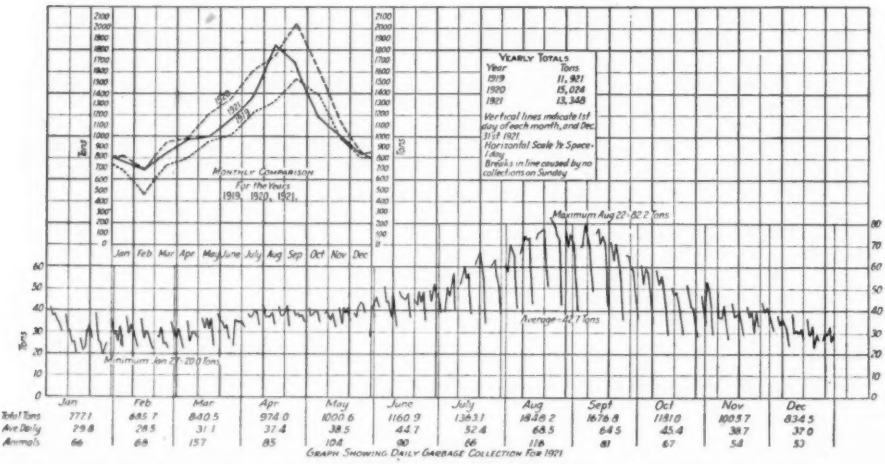
Yearly Totals
Year Tons
1919 11,921
1920 15,024
1921 13,348
Vertical lines indicate 1st day of each month, and Dec. 31st 1921
Horizontal Scale Is Space-1 day
Breaks in line caused by no collections on Sunday
Monthly Comparison For the Years 1919, 1920, 1921.
Maximum Aug 22-82.2 Tons
Average-42.7 Tons
Minimum Jan 27-20.0 Tons
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Total Tons 777.1 685.7 840.5 974.0 1000.6 1160.9 1363.1 1848.2 1678.8 1181.0 1005.7 834.5
Ave Daily 29.8 26.5 31.1 37.4 38.5 44.7 52.4 68.5 64.5 45.4 38.7 37.0
Animals 66 69 157 85 104 90 66 116 81 67 54 53
Graph Showing Daily Garbage Collection For 1921

DIAGRAM OF GARBAGE COLLECTION STATISTICS FOR AKRON, OHIO, FOR YEAR 1921.

TABLE IV—GARBAGE COLLECTION, AKRON, OHIO—TRUCK AND TRACTOR OPERATION, 1921.

	No. 66 Reo Speed 1921		No. 67 Packard 5T. 1918		No. 67 Packard 5T. 1918 Used as Shuttle-Car to Spot Trailers		No. 68 White 5T. 1920		No. 69 White 5T. 1920		No. 88 Mack 15T. Tractor 1921		No. 89 White5T. Tractor 1921	
Performance														
No. of Days Operated	277	.....	115	.....	73	.....	243	.....	257	.....	186	.....	169	.....
No. of Trips	.....	.....	241	.....	.....	.....	459	.....	507	.....	261	.....	248	.....
No. of Tons Carried	.....	.....	1,586	.....	.....	.....	3112	.....	3,467	.....	2,750	.....	2,182	.....
Miles	7,708	.....	4,374	.....	.....	.....	8,334	.....	9,149	.....	4,872	.....	4,761	.....
Ton-miles	.....	.....	14,400	.....	.....	.....	28,250	.....	31,250	.....	25,700	.....	20,950	.....
Costs														
Driver—Wages	1,694.25	.....	676.50	.....	430.25	.....	1,362.00	.....	1,506.00	.....	1,121.75	.....	1,014.00	.....
Helper—Wages	.....	.....	.....	.....	.....	320.00	11.60	.....	.....	.....	950.50	.....	876.28	.....
Gasoline and Oil	203.09	.....	752.67	.....	306.92	.....	760.79	.....	993.62	.....	710.27	.....	609.21	.....
Total Operating	.....	1,897.34	.....	1,429.07	.....	1,057.17	.....	2,134.39	.....	2,499.62	.....	2,782.52	.....	2,499.49
Repair—Wages	60.70	.....	132.70	.....	71.00	.....	643.70	.....	397.60	.....	11.00	.....	61.00	.....
Repairs—Parts	104.05	.....	189.00	.....	151.60	.....	398.38	.....	766.53	.....	24.61	.....	155.39	.....
Total Maintenance	.....	164.75	.....	321.70	.....	222.60	.....	1,042.08	.....	1,164.13	.....	35.61	.....	216.39
Tire Cost	.....	.....	.....	242.00	.....	187.50	.....	781.11	.....	551.45	.....	.....	.....	414.00
Depreciation	355.00	.....	690.00	.....	557.00	.....	1,213.20	.....	1,213.20	.....	620.00	.....	600.00	.....
Interest @ 5%	71.00	.....	165.00	.....	133.00	.....	337.00	.....	337.00	.....	173.00	.....	166.00	.....
Total Capital Charges	.....	426.00	.....	855.00	.....	690.00	.....	1,550.20	.....	1,550.20	.....	793.00	.....	766.00
Insurance	.....	.....	.....	100.00	.....	78.50	.....	178.50	.....	178.50	.....	156.50	.....	136.50
Total Cost	.....	2,488.09	.....	2,947.77	.....	2,235.77	.....	5,686.28	.....	5,943.90	.....	3,767.63	.....	4,032.38
Units Cost Per Ton Mile	.....	.....	.....	0.205	.....	.....	.....	0.201	.....	0.190	.....	0.147	.....	0.192

TABLE V—GARBAGE COLLECTION, AKRON OHIO—SUMMARY COST OF COLLECTION AND DELIVERY, 1921.

Truck Operation	8,414 tons
Road Maintenance	1,488.10
Truck 67, Table IV	$2,947.77
Truck 68, Table IV	5,686.28
Truck 69, Table IV	5,943.90
Truck 66 Complaints	784.05
	$16,850.10
Delivery cost per ton trucks	$2.00
Collection costs per ton wagons (Table II)	8.64
Total cost per ton—collection and delivery	$10.64
Tractor Operation	4,932 tons
Tractor 88, Table IV	$3,767.63
Tractor 89, Table IV	4,032.38
Truck 67, Table IV	2,235.77
Truck 66 Complaints	460.00
Road maintenance	872.00
	$11,367.78
Delivery cost per ton, tractors	$2.31
Collection costs per ton, trailers (Table II)	6.98
Total cost per ton—collection and delivery	$9.28

has proved effective. Routes formerly contributing but one load per team-day have with trailer service given 2 loads —in some cases 3 loads, though in the last case special and uneconomic labor methods were employed. Costs locally are high. They could be reduced were equipment used more fully, or were it possible to lengthen the time devoted to collection. Road conditions have a considerable influence upon ability to use trailers.

Akron garbage collection is under the detailed control of B. H. Rawson as Superintendent of Garbage Collection. E. A. Zeisloft, M. Am. Soc. C. E., is Director of Public Service.

MODELS OF MOTORIZED ROAD BUILDING EQUIPMENT EXHIBITED AT CHICAGO ROAD SHOW

A brief description of the Kissel road building equipment exhibited at the Chicago road show was published in the January issue of this magazine; a picture of the exhibit is shown on the title page of this section.

The photograph shows, left to right, the skip of the concrete mixer, then the special designed turntable that will turn a loaded truck around in 10 seconds preparatory to backing up to the mixer; next a replica of one of the special Kissel road builder's trucks which was designed and built to carry a 3 cu. yd. body divided for 3 batches of 1 cu. yd. each; next the Kissel designed and built and patent-

applied-for combination cement hopper and measuring boxes, under which the Kissel truck is driven and receives its properly measured load of cement in less than 5 seconds; next is one of the Kissel designed patented and built combination sand and stone hopper and measuring boxes which dumps properly proportioned loads of sand and stone into the 3-batch body in 5 seconds.

The fact that this miniature layout attracted considerable attention among the old and experienced contractors and road builders at the show proved that they realized how much engineering service has revolutionized the handling and loading of materials, eliminating waste and saving time and labor as compared to the old-fashioned shovel and wheelbarrow methods.

Every visitor was bent on learning how he can save time and labor on his road contracts this year. He also appreciated the fact that the motor truck in connection with the different loading and unloading equipment offers the most economical as well as the quickest way of getting the proper materials to the mixer. It is now possible to keep the mixer running every second throughout the working day and, as every contractor knows, this is what creates maximum footage at minimum cost. The one big impression the show left on visitors is that road building has been brought down to a systematic and economical basis, which will enable the contractor to lay more road at a lower cost, which means a saving to the public and at the same time the contractor can make more money for himself through the time and labor this motorized equipment saves him.

MOTOR TRUCK NEWS NOTES

12 *Acme 3-Tonners on Building Construction Job.*

When the Hudson Motor Car Company of Detroit, found that new manufacturing facilities and space were needed for building the Essex car, orders were given to start construction work at once. Excavating for the foundations was the first step.

ACME 3½-TON DUMP TRUCK OPERATED IN CONJUNCTION WITH OSGOOD CLAMSHELL OUTFIT ON BUILDING EXCAVATION IN DETROIT.

How this part of the work was accomplished is shown by the accompanying view illustrating an Osgood 18 clamshell outfit loading a 3½-ton Acme dump truck. This particular 3½-tonner is one of a fleet of 12 Acme trucks which were engaged in the work, the majority of the trucks being furnished by the Kaufman Cartage Co., of Detroit.

In addition to excavating, frozen sand and gravel were taken from stock pile and transported to the sections of the new plant under course of construction.

One Truck Hauls More Than Seven Teams

An interesting comparison has been made in the Oklahoma Highway Bulletin with regard to teams versus motor materials. A road contractor while doing State aid work of hauling crushed stone, employed 7 teams, 7 drivers and one 3½-ton motor truck. The 7 teams had each hauled 3 loads of 1½ yds. per day, a total of 4½ yds. daily. By motor truck he hauled 33 yds. each day. Figuring the cost of each team and driver at $7.25, the total amount was $50.75 per day for 7 teams. The 3½-ton motor truck actually hauled more material each day than 7 teams. The operating expenses of the motor truck figured to $18.40 per day, thereby effecting a daily saving of $32.25. The distance of the haul was 4½ miles each way, or a total of 9 miles.

UNIFORM LEGISLATION AS AFFECTING HIGHWAY TRAFFIC AND HIGHWAY TRANSPORT

By D. C. Fenner, Manager Public Works Department, International Motor Co., 25 Broadway, New York, N. Y.

Any discussion and understanding of uniform legislation as affecting highway traffic and highway transport must be based upon a thorough knowledge of the political structure of the governmental units in which highway traffic and highway transport prevail. This observation seems almost axiomatic and perhaps superfluous, yet too often in voicing the desirability and need for uniform motor vehicle legislation we overlook the fact that motor vehicles in their operation pass through the border lines of and come in turn, under the jurisdiction of municipalities, counties and states.

As for municipal control over highway traffic and highway transport, the kind and degree of such control is dependent either upon the constitutional rights which any state may give to its municipalities, or else upon the laws which states have enacted delegating more or less of their own power on the subject to some or all such municipalities.

While it is true that as a general rule the municipalities may not enact ordinances regulating highway traffic and highway transport along lines in conflict with the provisions of the general state motor vehicle laws, nevertheless, there are numerous important exceptions to this rule. Then, too, there are matters such as the regulation of motor vehicle operation in front of schools, churches, etc., which are matters of local concern and are usually left to the municipalities for regulation.

By a process of elimination, therefore, we arrive at the fact that under present conditions ultimate control in the matter of legislation governing highway traffic and highway transport lies in the legislatures of our various states. It is to these state legislatures, therefore, that in last analysis we must look for that vital and important end—namely, uniformity of motor vehicle laws and uniformity of enforcement.

Uniform legislation does not mean, necessarily, that all states should adopt one and the same law, identical in all their provisions. This might be considered the ideal condition, but from a practical standpoint, it is not necessary.

What is needed, however, is uniformity in those sections of the state laws that deal with definition of terms, traffic regulations, hand signals, qualifications for drivers, size and weight restrictions, obligatory equipment of a vehicle, headlight laws, and disposition of license fees.

Let us take a specific instance to illustrate this point: From the standpoint of the trucking business, which is today assuming very large proportions, no factor is more important than that the various states and their political subdivisions should impose one and the same set of rules and regulations governing the weight limits which such trucks are allowed to carry. A very encouraging procedure in the states of Connecticut and New Jersey restricts the load upon a motor truck to the manufacturer's rated capacity of the vehicle. As the enforcement of this provision will absolutely prevent overloading, it gives the manufacturers a chance to co-operate with the state highway engineers in the design and proper rating of vehicles for the protection of the highways.

The standard specification for a motor truck chassis now contains the allowable gross weight of the chassis and body and load, and also the actual chassis weight. It is possible that these two weights will be the only ones stamped on the truck caution plate by the manufacturer, and that the actual weight of body and the resultant pay load capacity must be stamped on the plate by the owner of the

truck before he can obtain his vehicle license plates. Similarly in the operation of passenger cars there are virtually as many laws on the subject of head lamps and head lighting as there are states in the Union, and no one starting out on a tour is able to be sure that perhaps at any moment or at any place he will not be arrested and severely penalized for the breach of some law or regulation at variance with the ones of his own state with which he is familiar and whose observance has become a matter of habit.

This wide variation in state motor vehicle laws and the unsatisfactory conditions resulting therefrom are greatly aggravated when there are local ordinances additional to or at variance with those laid down in the state laws. Obviously, therefore, the economical operation of a motor vehicle, even within the confines of a state becomes more or less of a gamble.

The remedy for these unsatisfactory conditions lies, of course, in uniformity of state laws having to do with the operation of motor vehicles and uniformity in county or other municipal ordinances. Furthermore, the local ordinances must in every respect conform to the general principles set forth in the uniform state laws. Several movements to accomplish this end have been begun, but the one which has attracted the most support and has gained the greatest headway is that which is now being sponsored and furthered by the Motor Vehicle Conference Committee, an organization composed of representatives from the American Automobile Association, Motor and Accessory Manufacturers' Association, National Automobile Chamber of Commerce, National Automobile Dealers' Association, Rubber Association of America, and the Trailer Association of America. Their views on the matter of uniform state legislation are set forth in a so-called proposed Uniform Motor Vehicle Law and Proposed Uniform Anti-Theft Law. To be sure, these measures contain many features to which persons have taken exception, and it is quite possible to point out sins of commission and omission in their provisions. Nevertheless, their recommendations reflect the views of able and experienced men in matters having to do with highway traffic and highway transport, and it is gratifying to know that many of the recommendations of these two proposed laws are finding their way, if not verbatim, at least in principle, into many of the laws of our states.

More important, however, than this is the fact that the extensive and intensive work that has been done in advocating the proposed Uniform Vehicle Law and Proposed Anti-Theft Law have brought home to the public and their lawmakers the fact that the time has come when uniformity in the regulation of highway traffic and highway transport is absolutely necessary for the safety and convenience of vehicular and pedestrian traffic. In consequence, I bespeak your interest in and strong support for every movement throughout the United States which has this end in view and based upon specific principles and fairness and justice to all concerned.

The foregoing paper was presented at the recent annual meeting of the American Road Builders' Association.

PERSONAL NOTES

H. O. Garman has entered private practice in consulting engineering and the management and operation of public utilities with offices in Indianapolis, Indiana. For more than 14 years Mr. Garman was chief engineer of the Public Service Commission and the Railroad Commission of Indiana, serving under five governors. During this time he valued many hundreds of Indiana properties totaling more than $300,000,000. Mr. Garman is national president of the American Association of Engineers.

President of the National Drainage Congress, Clark E. Jacoby, has appointed the following committee as members of the National Legislative Committee, which will appear before the various Congressional Committees in behalf of National Reclamation Laws for Swamp, Cut-over and Overflowed lands: F. H. Newell, Chairman, 1839 Phelps Place, N. W., Washington, D. C.; Mark W. Potter, Interstate Commerce Commission, Washington; Hon. John H. Small, 940 Munsey Bldg., Washington, D. C.; Col. Joseph Hyde Pratt, Chapel Hill, N. C.; Edgar A. Rossiter, Civil Engineer, Chicago, Ill.

Mr. Leo Hudson, Assoc. M. Am. Soc. C. E., and Mr. John P. Myron, M. Am. Soc. C. E., have formed a partnership for the practice of engineering under the firm name of Hudson & Myron, Engineers, with offices at 808-810 Wabash Building, Pittsburgh, Pa. Mr. Hudson has been in private practice for the last 15 years, principally on waterworks, sewerage, power plants, valuations and rates. Mr. Myron, until recently, was for a period of over 17 years, connected with the Pittsburgh

Filter & Engineering Company as Secretary and Engineer.

R. F. Kelker, Jr., M. D. Gates and C. E. DeLeuw, announced the dissolution of the firm of Kelker, Gates & DeLeuw, of Chicago, effective Jan. 1, 1922. The new firm of Kelker, DeLeuw & Co., has taken over all current contracts except the Platte Valley Drainage District of Worth County, Mo., and the Upper Salt Creek Drainage District of Logan County, Ill., which will be handled by Mr. Gates. Kelker, DeLeuw & Co., will engage in general municipal and sanitary engineering, with offices in the Conway Building, Chicago.

Harry P. Grier, formerly of Statesville, N. C., and formerly County Engineer for Iredell and Alexander Counties, N. C., has been appointed District Engineer for the Asphalt Association, with headquarters in Raleigh, N. C. He will aid highway engineers and officials in working out their paving problems wherever asphalt is a factor.

George L. Sawyer, formerly Sales Manager of material handling machinery for the Barber-Greene Co., of Aurora, Ill., has been appointed to represent the Universal Crane Co., in the New York field, with offices at Allied Machinery Center, 141 Center St., New York City.

Mr. C. Gray, for some time Acting Chief Engineer of the Indiana State Highway Commission, has been appointed Chief Engineer.

Following the death of Lewis S. Sadler, Highway Commissioner of Pennsylvania, Governor Sproul announced that George H. Biles, assistant Highway Commissioner, will direct the affairs of the Pennsylvania State Highway Department.

Commissioner Biles has been with the State Highway Department since June, 1905, when he was appointed Chief Draftsman. Prior to that time he was associated for several years with the Philadelphia Department of Public Works. In June, 1906, he was named Division Engineer in charge of the central and a portion of the eastern counties of Pennsylvania, and conducted for the State Highway Department some of the first experiments in bituminous road materials. As Division Engineer he supervised the construction of the famous Lewistown Narrows model road, the first highway built under the Sproul Highway Act. He also built the river drive out of the city of Harrisburg. In December, 1912, Mr. Biles was appointed assistant to the Chief Engineer and in 1913 he became Maintenance Engineer, organizing the Maintenance Division and assuming direct charge of all maintenance on State Highways and State-aid roads. In June, 1915, he was named Second Deputy State Highway Commissioner, and in 1918, in addition to his supervision of maintenance, was placed in charge of all construction and administrative work. When Lewis S. Sadler became State Highway Commissioner, Mr. Biles was named Assistant Highway Commissioner. Plans of the State Highway department for the 1922 construction season, as tentatively decided upon during the lifetime of the late Highway Commissioner Lowis S. Sadler, will be carried out.

The United States Cast Iron Pipe & Foundry Co., has opened a new office at 811 Dixie Terminal Bldg., Cincinnati, O. Mr. P. T. Laws, Assistant Works Manager, will make this point his headquarters. Sales from this office will be in charge of Mr. Harold G. Henderson.

A HANDY FORE-SIGHT ON STREET WORK

By M. Y. Crowdus, City Engineering Dept., City Hall, Nashville, Tenn.

When staking out curbing on streets the transit is very often so close to the car tracks that the vibration of the passing street cars throws the instrument out of alignment. This necessitates constant reference to a fore-sight, and fore-sights on city streets are difficult to establish, and a nail, or tack or pencil is quickly knocked down by passing automobiles.

A sturdy, dependable fore-sight may be constructed from a square or triangular shaped bar of steel, 12 ins. long, and 2 ins. thick, its faces painted white with red division lines spaced 0.01 ft.

The transitman may at any time place this "fore-sight" 100 ft. or so ahead of his instrument, for constant reference. Automobiles will not greatly disturb the heavy bar, especially if of triangular shape, and should a passing car run over the bar, the transitman has only to "pick up" another red line for a new fore-sight.

LICENSING ENGINEERS IN UTAH

The Legislative Committee of the Ogden Chapter of the American Association of Engineers, in conjunction with other chapters and engineering organizations of the State of Utah, has taken action toward having bills introduced at the next Legislature for civil service, zoning, and licensing of engineers in Utah.

KENTUCKY ROCK Kyrock ASPHALT

Striking Recognition of Merit

ALTHOUGH the presence of vast deposits of natural rock asphalt in Western Kentucky has been known for a quarter of a century, it was only a little over three year ago that engineers and capital braved the difficulties of this rugged country, and attempted its production on a large scale.

Since that time, some three and one-half million square yards of Kentucky Rock Asphalt pavement has been laid.

Ten states have included Kentucky Rock Asphalt in their standard specifications.

The United States Bureau of Roads has repeatedly approved this natural paving material for federal aid on the heaviest traffic roads.

In 1920 Kentucky Rock Asphalt was used on state and county roads and for city streets, drives and maintenance, in thirteen states.

Kentucky Rock Asphalt is winning on real merit. Its use increases just as rapidly as the production justifies introduction into new fields.

* * * *

Kentucky Rock Asphalt is a perfect asphalt mix. The mineral aggregate is pure angular silica sand, each grain 100 per cent coated with live bitumen.

The material is shipped ready to lay cold on any type of base sufficient to carry the traffic.

No mixing, heating or other special equipment, no expert workmen are required to build a successful pavement.

Kentucky Rock Asphalt makes a pavement equal in every respect, and superior in many ways, to the most successful sheet asphalt. It is noiseless, dustless and resilient. It does not crack, roll, buckle or bleed.

The simplicity of Kentucky Rock Asphalt construction, due to the fact that it may be laid cold without special binder course or curb, makes it possible to build the highest type asphalt highways, where the cost and physical difficulties of laying other pavements would be prohibitive. In cases where the old road will serve as a base, Kentucky Rock Asphalt means a still greater saving.

* * * *

Kentucky Rock Asphalt was formed by nature in a process requiring untold centuries. It is incapable of experiment. Either it is or is not a successful pavement. Kentucky Rock Asphalt highways which have stood up under the heaviest traffic for years, have more than proven its unusual merit.

Each ton of Kentucky Rock Asphalt which leaves the pulverizing mills is laboratory tested to insure absolute uniformity. Material shipped today is the same as that used on the famous Camp Knox road at Louisville, the Nelson Avenue road in Ohio, the Midland Trail in Kentucky and other highways which have withstood heavy traffic for year.

Laid on an adequate base, Kentucky Rock Asphalt always gives maximum results.

Our new booklet gives the complete story of Kentucky Rock Asphalt and descriptions of many old roads. Write for Booklet E.

Kentucky Rock Asphalt Company

INCORPORATED

711-718 Marion E. Taylor Bldg. **LOUISVILLE, KY.**

EDITORIALS

WHAT IS PROFESSIONAL ENGINEERING?

Many who have never been greatly interested in the attempts to define engineering are now conscious of the need for at least a common understanding of the meaning of the term "professional engineering" even if a satisfactory definition of "engineering" cannot be formulated. Of course there have been made many attempt to define enginering. At least one such definition has been current for many years, that of Treadgold, and it has been quoted innumerable times, but it is so broad that it may fairly be said to include farmers, miners, and perhaps others, as well as engineers. This has been the great difficulty in attempting to define "engineer" and "engineering;" namely, if the definition is made broad enough to include all branches of engineering, and at the same time is kept short enough to be at all useful, it comes very close to including everybody and everything else besides "engineers" and "engineering."

Now that state boards are licensing men to practice "professional engineering," however, one must give serious thought to the meaning of that term, no matter how fully convinced he may be of the futility of trying to define the term so it will mean the same thing to the boards, the engineers and the general public. In fact, the tendency on the part of some boards to place a narrow interpretation on the term is the very thing which is creating serious friction between the boards and the men who have considered themselves engineers and who have been so taken and accepted by the public.

It may be doubted if it is feasible to formulate a definition of professional enginering which will be generally acceptable unless it is made so involved and so full of qualifying clauses that it would not be readily useful. If this is true one must rely on description, or accepted usage, in preference to precise definition.

We believe it is possible for the boards and the engineers to reach an understanding in the interpretation of license laws, and such an understanding is greatly desired by all, if the boards will accept, within limits perhaps, the generally accepted usage of the term "professional engineering."

Now what do we all mean when we speak of a "professional engineer." Just this: we mean to differentiate between the man who drives a locomotive, or operates a hoisting or other form of stationary engine, and the man who applies the principles of engineering science as it is taught in the recognized engineering courses of study in our schools and colleges. It was not until unsuccessful attempts had been made to get the public to use such terms as "engineman" and "engine-driver" that some genius thought of using the term "professional engineer" to prevent confusion in the popular mind. The young man who had graduated from an engineering college and who made his living by following the line of work for which he had been schooled did not like, for a variety of reasons, to be asked: "What road do you run on?" We insist, in all seriousness, that it was the accumulation of a multitude of such misunderstandings, each perhaps trivial in itself, which lead to the adoption of the term "professional engineer," simply and solely to remove a natural cause for confusion in the popular mind.

Stated in this way the subject loses much of its mystery and that, of course, is what we desire to accomplish in this discussion. We believe we have described, if we have not defined, the generally accepted meaning of the term "professional engineering" and have indicated the broad common ground of complete mutual understanding on which we know the boards and the engineers so greatly desire to come together.

We believe the boards should adopt the meaning of "professional engineering" here described, "within certain limits," perhaps. What limits? Limits as to responsibility, age, experience, ability, etc. In other words, lines must be drawn here as elsewhere and the question reduces itself to this: "Where shall we draw the line; when does a man cease being a clerk in an engineer's office and become an engineer?" Our criticism of the boards is that they have placed the line much too high, over the heads, in fact,

of the majority. While it is true that the older men are the brain of the profession, and are honored by all as such, it is equally true that the younger men are its bone and sinew, yes, its very life blood; each would be nearly useless without the other.

The state admits to the practice of law and medicine many who are very far behind the leaders in those professions in ability and it must do the same with engineers. All engineers are not first class engineers, but many who are not are decidedly useful citizens and are deserving of recognition of their professional status by the state. To withhold a license is to brand as incompetent, and the vast majority of engineers are decidedly competent.

If the line is placed so high that only a small minority of men in engineering work are recognized by the state as "professional engineers," while the great majority of them are virtually rated, by inference, as clerks, it is only natural that the reaction on the majority will be most unfortunate to them, to the profession as a whole, and to the public, for it inevitably will drive them into organized movements having some of the characteristics of trade unionism of which engineers do not approve. Thus, licensing which might elevate the profession may debase it. In seeking to accomplish too much at the outset the boards may do more harm than good.

THE 3 IN. PAVING BRICK

In discussing the standardized paving brick, in an article to be found in this issue, the author expresses doubt as to the ultimate economy and serviceability of the 3-in. brick. Of course only time will tell whether or not brick of this depth may safely be specified by the careful engineer. Not enough experience has yet been had to warrant anything like final judgment in the matter. It may be that the fears of the author, for whose views the profession rightly entertains great respect, may prove well founded with reference to this brick. Of course if it cannot stand up under service requirements it will be abandoned in favor of brick of greater depth.

We have been disposed to look upon the shallow brick with favor; at least we feel that it is deserving of a thorough trial. It may be that we are slightly prejudiced in its favor for we see in this attempt to economize in material the very essence of good engineering. Of course there is such a thing as cutting too fine: but that is the question which time alone can answer.

Meanwhile, those interested in the subject will note that the shallow brick is sponsored by some men who have devoted much study to the subject; men of great experience and wide observation. As our readers know, the present eleven standard varieties of paving brick provide for 3, 3½ or 4-inch wearing surfaces with a view of providing brick pavements suitable for varying traffic requirements.

The straight wire cut brick of 3 in. depth, asphalt filled, has its staunch defenders. In fact, since 1917 this variety of brick has risen from approximately 5 per cent of all brick shipped to approximately 43 per cent, and the proportion is still on the increase.

STREET LIGHTING PROGRESS IN 18 YEARS.

We have remarked in this department, on various occasions, that municipal engineering is steadily advancing, although the change from month to month is so slight that it is readily assimilated by the engineer who cares to keep up to date. This truth becomes very evident when we go back from ten to twenty years and note the great changes which have occurred in municipal engineering practice since that time.

We are indebted to an engineer reader for an unusually forceful illustration of the progress in street lighting since the year 1904. In that year the clerk of an Iowa town wrote to the clerk of a Minnesota town:

"We have your inquiry in regard to our experience with gas lighting plants. Our experience with acetylene gas was a sad one as follows: Constructed and completed in September, froze up in October, exploded in January; two funerals three days later. Was constructed and owned by Bingville people under a franchise granted. If you think you want acetylene gas, you can get piping, remnants of machinery and buildings and perhaps some tombstones by applying to the Blank Construction Co. of Bingville. I think you can get some plate glass also, as they had to furnish this town with several hundred dollars' worth and perhaps have some on hand for future use."

IMPORTANCE OF SURFACE FINISH AND METHODS OF CONTROL IN PAVEMENT CONSTRUCTION

By H. Eltinge Breed, Consulting Engineer, 507 Fifth Ave., New York, N. Y.

Apparently a strong mental tendency is to disregard the obvious and seek the remote. Perhaps this is because the obvious is often an aggregation of trifles, while the remote may be striking, stupendous. Certain it is that almost any more obscure cause may be heard given for the success or failure of any road, than the simple one of surface finish. Yet, I believe that in the concrete road economically designed, the life of the pavement depends as much upon the surface finish as upon any other factor.

We know now that impact is the great cause of destruction in our pavements. Impact is the bumping or banging of one object upon another. As I roll a smooth cylinder along a smooth table there is practically no impact but let ridges appear in the table, and as the cylinder bumps along over them, you get a series of impacts that, if the cylinder be heavy enough and rolled often enough, will soon wear out the surface and damage the structure.

That is analogous to what is happening to our roads. If the wheels of vehicles are smooth and the pavement surface is smooth there is no damaging impact from traffic. The road lives even though it be weak in proportion to the volume and weight of traffic it must carry. But let surface irregularities develop, and no matter how strongly built, the whole pavement soon shows the effects of wear. We build our roads on an average to withstand a pressure of 800 lbs. per lineal inch width of tire. Yet, if an unevenness in surface of only ¼-in. occurs, the impact of one rear wheel of a 5-ton truck may exert an impact pressure upon the road of 20,000 lbs. Under such pressure, the unevenness becomes a depression whose edges spall and break, causing further impacts and more depressions until the pavement is badly damaged.

In order to lessen impact we must get and keep smooth surfaces. How can we do it? Close scrutiny of work and infinite attention to detail are essential. Then there are certain general remedies suggested by the general causes of unevenness, specific remedies being tried by different states or on different jobs, and different methods of work and machinery.

Causes of Unevenness in Pavement Surface

There are five general causes of unevenness in the pavement surface:

1. Foreign materials in the aggregate, which, failing to amalgamate are ousted, leaving holes and depressions.
2. Non-uniform aggregates, which cause inequalities in wearing resistance to traffic, and subsequent depressions in the weaker places.
3. Poor workmanship in striking off and finishing.
4. Cracks, longitudinal and transverse, due to frost action, changes of temperature or unequal bearing power in the subsoil.
5. Uneven joints, perhaps the most common cause of surface trouble, due often to the piling up of joint material or to difference in elevation of slab surface.

Remedies for Surface Unevenness

The general remedies for surface unevenness are as obvious as the unevenness itself, and therefore, perhaps, as often neglected—strict specifications exacting good material and good workmanship. More and more we are getting these on paper. The problem is their application to the job, because there is where the human element enters. How solve the personal equation between engineer and contractor? I wish that sometime we might have fuller discussion on this point. The answer is at once made that the relationship should be one of co-operation and mutual endeavor toward a common end—the best possible road. But as long as private profit outdistances social welfare as an aim in our economic life, just so long are we often going to have the contractor trying to get all he can out of a job, while the engineer is trying to make him put all he can into it. So, sometimes the letter of the specifications is violated, and frequently their spirit. When all engineers know their job so well that they can show contractors easier and better methods of doing their work, and when all contractors regard highway work as a legitimate industry and not a financial gamble, then we shall have that adherence to specifications that will insure good work and smooth surfaces.

Three other general methods of preserving good surface finish, once it is obtained, are the use of steel reinforcement, the division of the road longitudinally, and the wider spacing of joints with the use of dowels.

Advantages of Steel Reinforcement

Theadvantages of steel reinforcement are that it gives the road greater bearing power and greater resistance to frost action and that it offsets irregularities and weakness in the subsoil. By helping to preserve the integrity of the pavement, it minimizes any tendency toward cracking, which is of course a cause of surface unevenness.

The division of the road longitudinally increases its beam strength about fourfold. Observation reveals that longitudinal cracks are not found in slabs 9 and 10 ft. wide, though we have all encountered them in slabs beyond that width. The reason for this difference is still conjectural, but until it is ascertained we would do well to be guided by results hitherto obtained.

Use of Longer Slabs

Transverse joints being a prolific source of trouble, it is well to diminish their number as far as possible through the use of the longer slab. This wider spacing of joints becomes feasible through the use of steel reinforcement to meet the temperature stresses of the slab. The use of dowels gives stability to the joints and holds the surface even. The submergence of joints an inch below the surface has proven unsatisfactory. Devised at first to secure a smooth surface and permit the use of a finishing machine, it seemed admirable until subsequent expansion crowded and crushed the concrete above the joint material, leaving a badly ravelled and spalled joint. The best method that I have found of making a joint is to submerge the joint material until after the screed or finishing machine has passed over it; then to lift the joint material slightly above the surface with long fingered tongs; then to finish the joint with the split float or split roller, rounding the concrete next to the joint material with an edging tool.

Specific application of these general principles is found in the requirements of such states as Delaware, Pennsylvania and New York. In these states, and in others, the specifications exact good workmanship by allowing a maximum of only ¼-in. depression in 10 ft. of pavement tested with a straight edge. The use of the straight edge on green concrete indicates depressions to be rectified and insures good results. These states specify materials with such precision as almost certainly to preclude the use of foreign materials in the aggregate or of non-uniform aggregates. They design the roads so as to minimize the danger of movement in the slab and resulting cracks. And they give special attention to the placing of joints and to the suitability of the machinery in use.

All of these precautions were taken on the road built last summer in Old Bennington, Vermont, by the Fred T. Ley Co., and so far not the slightest indication of any surface unevenness has appeared on it. This tends to support my belief that we are going to be able to build roads within necessary financial limits that under the traffic permitted by law will be practically indestructible.

Belting and Rolling the Surface

The actual method of finishing is of course important in securing a smooth surface. Some road builders prefer to use the finishing machine with the roller and belt. It is essential that the roller be light. A too-heavy roller pushes the crown out of the pavement, and spoils the surface. Most specifications call for a weight of from 12 to 15 lbs. per foot length. Some builders omit the roller, using only the machine. My own experience indicates that the roller helps. One advantage of the finishing machine is that a dryer concrete can be used with it, which gives greater strength to the pavement. It also gives more uniform results than can be obtained with a green gang, and seems in general more foolproof than the hand method. Still, many prefer to strike off with the hand screed, using the roller and belt. This has the advantage of making one less piece of plant to get out of order and where a heavy screed is used in the hands of competent workmen it gives as smooth a finish as the finishing machine.

With either method the board belt gives unquestionably the best finish. The bow belt, however, can give good results. Proper belting takes off not only the water, but also the clay loam, laitance, etc., that tend to form scale on the surface.

I have tried in this paper to call attention only the salient features in securing surface smoothness in the hope that a hasty summary might help to bring practice and theory closer together so that theory might receive fresh impetus to discover the something new on the subject that I have not been able to find and tell you.

The foregoing paper by Mr. Breed was presented at the recent annual meeting of the American Road Builders' Association.

HIGHWAY ENGINEER INDORSES TYPE OF ROAD DRAINAGE RECOMMENDED BY DRAINAGE EXPERT

To the Editor:

I have before me a copy of your magazine for January, 1922, namely, Vol. LXII, No. 1, in which is an article by Edgar A. Rossiter, Consulting Civil Engineer of Chicago, entitled, "A Drainage Expert's Ideas on Highway Construction."

I cannot agree with Major Rossiter in all of the thoughts which he expresses, but desire to state that from my personal experience covering 8 eight years in the construction and maintenance of improved state highways, I can, without reservation, substantiate his drainage design as shown by Fig. 3 on page 12, in the said issue of your magazine.

As the Major states, "Our technical papers, books and magazines for the last 10 years have been filled with articles relative to highway construction . . ." "To the layman man yof these articles are but a pitiful confession of ignorance of highway construction by their authors."

As every student of highway work, even a superficial one, knows, these articles have passed from grave to gay and from the sublime to the ridiculous. One article may state that we need no drainage, and the next that it is the most important thing in road construction; another article makes the dogmatic statement that clay is a fluid; another that all the roads in New York State are built on gravel subsoil, etc., etc.; but, amongst this great number of articles there can be found many which are instructive, and the great trouble is to separate the wheat from the chaff.

Sometimes I have felt almost as Major Rossiter must have felt when he wrote this article, namely, that we were groping blindly in the dark, believing that a truth was within our reach but not knowing where to grasp in order to obtain it. Nevertheless, when I have considered that the integrity of our roads in this northern climate depends as much or more upon the handling of a force of which we know little or nothing, as on any other factor, it seems as if we had accomplished something of real value when I observe the road construction of the past 10 or 20 years.

The unknown force referred to is that occasioned by the freezing and thawing of our subgrades, and it is believed that this can never be determined with any degree of accuracy except through intelligent observation over a long period of time over various classes of soil and various classes of road pavement. The various experiments which have been made and which at present are being made upon so-called typical sections of roadway, it is believed, will constitute or produce nothing excepting some data upon which opinions might be formed, and that they will not produce actual bona fide facts from which the road builder can say: "Here you shall put this type of road, and there you shall put that type of road," knowing that no other type should be used in these places.

Major Rossiter as a hydraulic engineer, has shown in the aforementioned Fig. 3, exactly the type of drainage which has been developed by work done under my supervision during the past 7 or 8 years. Drainage of this type was placed in a road near the Canadian line 6 years ago. Prior to the placing of this drainage, this road "broke up" every spring, and in fact, actually looked as if a rooter plow had been run through the macadam. What we did was to roll the old macadam after the frost was out of the road, put on a new 3-in. macadam top with a bituminous binder, clean out our ditches and lay a line of tile in exactly the same position as shown on said Fig. 3, on that side of the road from which the sub-soil waters entered, as at that time we did not take into consideration the actual run-off from the road itself, of which Major Rossiter's article speaks.

Since that time this road has never failed. Moreover, since that time several pieces of road have been similarly fixed, and at the present time, I have a contract under way upon which 18,000 lin. ft. of exactly this kind of drainage is being placed, and in the past 4 or 5 years we have been fully aware that a large portion of the so-called "blow-ups" on our roads were caused by the freezing of water which soaked down through the road itself and not because of water which came in from the sides. This is proved by observation of several conditions during the past years, a few of which are as follows:

These blow-ups have occurred on roads where the ditch and culvert drainage was in good condition; they have occurred as often on the side hill, namely, the middle of a hill grade, as at the summit of the grade or at its base, or along the adjacent flat lands; they have occurred at times

on fills of several feet in height, as well as in cuts of varying depths. Therefore, we have been forced to the conclusion that good ditches are not sufficient, that our surface must be kept watertight, and that where there is danger from the run-off from the pavement itself seeping into the subgrade, it must be taken care of in the manner shown on said Fig. 3.

Do not think from the foregoing that we put in tile on all of our roads in the manner shown, or that we put it in every time that we are in doubt as to whether or not it is needed. We are designing our roads the best we can, all conditions considered, and there are many conditions which enter state highway work, some of which take precedence at times over the purely engineering features, and if Major Rossiter would get into the game as a state official, he would realize some of these conditions as well as those of us who are engaged therein.

Will you kindly thank Major Rossiter for this article, as I know there is far more good than bad in it, and am glad to have seen a copy of it.

Very truly yours,

T. M. RIPLEY, Division Engineer.

New York Commission of Highways, St. Ann Federation Bldg., Hornell, N. Y., Jan. 31, 1922.

ADMINISTERING ENGINEERS' LICENSE LAWS

To the Editor:

I was very much interested in your editorial on page 1 of the January issue entitled, "Administering Engineers' License Laws."

There is another aspect to this question which, while vitally serious, seems to be ignored by the engineering profession. This is the attempt by a license law, or its interpreters and administrators, to establish the practice of engineering as a business and not strictly as a profession.

Take a case in point with which I am fairly familiar. A law to license land surveyors (a minor division of civil and municipal engineering) became effective on January 1, 1920, in Cook County, Ill., which includes Chicago. This law applies to this *one* county in the State. The balance of the State remains "unprotected." This law was engineered quietly without apparent knowledge on the part of leading engineering societies. At the time the law became operative, a number of the local municipal engineers filed application for license, as per provision in the law, showing in all cases from 5 to 40 years' experience in surveying in Chicago—Cook County.

These men do the careful, disinterested surveying in laying out street and alley lines and defining property lines, in securing footage and preparing plots for condemnation in widening or extending streets, etc. Could they get a license, based on their practical, continuous professional experience? No! The Board ruled that one must be in *private business* on or before that date (Jan. 1, 1920), to be entitled to a license. Many incompetent men opened offices and were licensed without examination, while the truly competent surveyors who had worked for the city, or the great utility corporations, and, in many cases through their ability had advanced to higher classifications in engineering, were denied licenses; not because of their ability, which apparently was not given any weight, but because they were not in individual private practice. In other words, the administrators of the law seek to limit competition for their own advantage. Of course, a surveyor, or municipal engineer *employed* by the municipality, sanitary district, county and public corporations (on their own property) can work in his "official capacity" as a surveyor. If he loses his job apparently he cannot work as a surveyor. The apparently serious feature is that competent men, well qualified men, have no legal or professional standing.

Thus you have the peculiar spectacle of the more competent men, doing professional work, being unlicensed, while the incompetent, the least experienced, the out-of-date, discouraged class, are licensed and legally granted leadership (?) and a degree of unearned respectability over their more fortunate (or is it unfortunate) brothers!

Just such things as this discourage licensing and make the engineering profession ridiculous before the eyes of the public. I believe your publication could confer lasting benefit on the profession by investigating the various laws and their administration and secure their repeal or sensible modification.

A license law should be based on a man's ability in his chosen line. His education or employer has nothing to do with it. The present danger lies in extending this idea of malpractice or administration to laws yet (?) to come.

Very truly yours,

A CHICAGO ENGINEER.

Chicago, Ill., Jan. 27, 1922.

SCIENTIFIC ROAD BUILDING IN ILLINOIS

Illinois not only has attained a leading place among the states of the union as a road-building state, but it also has attained leadership in the matter of the scientific design and construction of paved trunk line highways.

In 1921 only one state—Pennsylvania—led Illinois in the construction of modern high type pavements; Pennsylvania having built 670 miles and Illinois 412 miles. New York was next with 347 miles, followed closely by Wisconsin with 340 miles. For 1922 Illinois has adopted the slogan of 1,000 additional miles of road paved and ready for traffic.

In a paper read before the American Road Builders' Association, in convention at Chicago, Clifford Older, chief highway engineer of the Department of Public Works and Buildings of Illinois, outlined Illinois' claim for leadership in matters relating to the scientific design of trunk line pavements.

Bates Experimental Road

With the large amount of money for road construction that had been made available by the passage of the Sixty Million Dollar Road Bond Issue Act, it was considered of extreme importance that "guess work" be eliminated from pavement design. With this in mind the construction of an experimental road near Springfield was undertaken. This is known as the Bates Experimental Road. It was started in 1920 and finished during the summer of 1921.

The Bates Road is about two miles in length, and includes 63 sections, each approximately 200 ft. long and representing all types of modern pavements; several thicknesses of each type being used so that when trucks are operated over the road with increasing loads, the capacity of each section, measured in terms of weight and numbers of trucks, will be plainly obvious.

Brief Outline of Research Work Carried On

Although the truck loading of this road has not yet taken place, the research work carried out by the department thus far indicates clearly, according to Mr. Older, just what may be expected of each type and each thickness. Already, many matters of great interest to engineers and of vital importance to the taxpayers and the road users, which have not heretofore been known, have been determined. For example: Heretofore it has been assumed that by means of tile drains the foundation soil under a pavement may be kept dry. Mr. Older brings out the fact that the Bates Road test shows that tile drains are practically useless as far as keeping the foundation soil dry is concerned, although they may prevent excessive "heaving" of the slab because of frost action. A surprising fact brought out by Mr. Older was that the amount of water in the soil, under a road slab may be as high as 40 per cent of the weight of the dry soil, and this in spite of the fact that tile drains may be placed along each edge of the pavement. In this paper it was further stated that rigid pavements, such as concrete and brick on a concrete base, are not fixed and rigid as the casual observer commonly believes, but are in constant motion even though no wagons or trucks may be moved over them. Such pavements lengthen and shorten due to changes in temperature; they stretch and shrink laterally due to the same causes. More important to the engineer, however, is the fact discovered by the Illinois Division of Highways that the unequal heating and cooling of the top as compared with the bottom surface of the pavement as the temperature of the air changes, causes the pavement slab to curl up at the edges at night to such an extent as to lift the edges entirely off the foundation soil. In the day time the reverse is true, when the center of the pavement is likely to be lifted entirely free from the foundation. The importance of this action may be appreciated when it is known that the edge of a concrete slab 7 ins. thick may lift above the foundation in extreme cases as much as ¼ in. at night. Obviously, pavement slabs must be designated for this condition.

As a result of these investigations, Mr. Older believes that Illinois has been enabled to design pavements having practically double the strength of the designs heretofore used, and yet at a saving in cost of approximately $1,500 per mile.

Another matter of interest brought out in this paper relates to the breaking down of concrete slabs under repeated loads, due to a fatigue of the slab. This may be better understood by an illustration. The Department has found that a truck wheel carrying a total weight of about 5 tons may pass along the edge of a 7-in. concrete pavement of the ordinary design once or twice without breaking the pave-

ment; yet if the same wheel passes along the edge from 10 to 50 times, the edge of the pavement breaks down in many places. Loads on such a pavement would have to be reduced to 2½ tons in order that trucks having wheel loads of this magnitude might be carried indefinitely by the pavement. Further, investigations have shown that a pavement may carry loads equal to 60 or 70 per cent of the critical loads only a few thousand times without breaking—in other words, in order to provide a reasonable factor of safety a pavement must not be loaded in excess of one-third of its apparent strength without danger of its failing in a comparatively short time.

Amount of Expenditure in Experimental Road Justified

Although the construction of the Bates road has involved a considerable expenditure of State funds this fund has already been returned many times in reduced construction costs and the knowledge gained as regards the construction of better roads. While the saving effected in the expenditure of the Sixty Million Dollar Road Fund will amount to a considerable sum because of the Bates experiment, yet this item is of far less importance than the saving of maintenance expense effected by the construction of the best pavements engineering can devise.

As stated in the beginning, it will eliminate the "guess work" from pavement design.

RECENT DEVELOPMENTS IN PAVEMENT CONSTRUCTION DETAILS

By Charles M. Upham, Chief Engineer, North Carolina State Highway Commission, Commercial National Bank Bldg., Raleigh, North Carolina.

The past two years seem notable in the fact that no great changes have been brought about or new methods introduced in the construction of modern type pavements, but rather the energy of progress has been expended in the development of many details which had previously proven themselves hindrances in economical road construction. With the present character of road materials, and the mechanical devices now in use, the types of pavements seem to have established themselves and to have settled within distinctive limits.

Half-Width Roads

The construction of half-width roads can hardly be called recent. It has been found that this method may be followed and satisfactory results obtained. This development of road construction releases the traffic from the long rough detours, which are very often present in road construction, and makes the road available for traffic during construction. This method has been utilized satisfactorily in the case of the construction of the bituminous type pavements, and, in a few instances, it has brought about good results in the construction of water-bound macadam, but it is generally used in concrete road construction. Where this road is constructed for a heavy duty road, it is very often heavily reinforced, and each half of the road is kept separate and apart from the other half, so that the complete pavement really consists of two strips of pavement laid side by side. In this method of construction the heavy reinforcement is longitudinal, and, on account of the center line joint taking up the vertical movement of the pavement, thus eliminating any longitudinal cracking, and the transverse cracking is decreased to a minimum, even in the part of the country that is subjected to heavy frost.

In other instances tie rods have been used to tie the two strips of pavement together. This method, however, introduces difficult details in construction, and at the present time has shown no particular advantage over the other. The practical advantage of the longitudinal joint is in the fact that the construction joint is easily maintained, and is not especially objectionable in appearance, while a jagged, irregular longitudinal crack is difficult to maintain, and is very unsightly in appearance.

In some states this longitudinal or center line construction joint is provided, even though the pavement is constructed in one operation, the advantage being the same as when the pavement is constructed in two sections.

Building Hard Shoulders on Old Macadam

Another recent development in road surface is the widening out and the reclaiming of old macadam roads by building a strip of hard surface pavement on each side of the macadam. On either side of the old macadam road varying from 5 to 10 ft. in width, there is placed a strip of concrete pavement from 9 to 10 ft. wide; these strips being sometimes reinforced. This method furnishes a comparatively wide pavement, and renders useful a road which would otherwise be

too narrow to be of any service to traffic.

Tendency to Increase Amount of Reinforcement in Concrete Roads

Another development in road surfacing has been the general tendency to increase the amount of reinforcement in concrete roads.

Only a short time ago many engineers were reinforcing their roads with metal wiring, approximately 25 to 27 lbs. to 100 square feet. At the present time it is a common practice to use approximately three times this amount, with the tendency to still further increase the weight of material. The Specifications of North Carolina for 1922 will undoubtedly call for metal amounting to nearly 100 lbs. for each 100 sq. ft. This has effected a large economical advantage in the cost of roads, which has brought a reinforced concrete surface to the point where the changes in reinforcements are not left to the imagination. The present price of steel has made it possible to create considerable saving in dollars by the construction of thinner concrete pavements. Where reinforcement has been used in most cases the road has been constructed of a universal thickness, this also affording a considerable saving of concrete.

Batch Transfer Method

Much progress has been made in the methods of laying concrete pavements, the tendency being not to allow concrete materials to be placed on the subgrade. The batch transfer method is now becoming a standard form of construction. This method has proven economical, in most instances, and capable of large yardage. There have been many combinations of this method, such as hauling by industrial railway with the batch boxes carried upon the railway cars; as well as the motor truck hauling with the batch boxes loaded on the trucks; and the trucks being provided with batch compartments. In some instances the batches have been hauled a portion of the distance by trucks and transferred to industrial railway. This has proven a very economical combination in many cases.

Central Mixing Plants

The central mixing plant for concrete pavements is now commending itself on many projects. In most cases the ready-mixed concrete is hauled to the construction by means of trucks. The only detail in this method which can be considered questionable at this time, is the transferring of the concrete from the trucks. It is possible in many cases that there is a segregation of aggregates and, no doubt, this detail must be overcome, but this method of construction is bound to gain in popularity from year to year.

In a few instances engineers are calling for a piece of bituminous surface road to be constructed of 1-2-4 concrete and requiring that the concrete base be properly cured, as called for in concrete surface, for a period of at least two weeks.

Burlap Covering of Green Concrete Pavements

For a long time the curing of concrete pavements has been neglected, and it is only recently that this detail of construction has been given the proper attention. One of the most important developments which has been brought about recently is the use of the burlap covering in the early curing of concrete surface. The finished pavement is covered with strips of burlap, approximately 4 ft. in width, and extending the entire width of the pavement. This burlap is kept wet and then placed on the finished concrete surface from about 10 to 20 ft. back of the finishing operation. The slight marking of the surface from the burlap is negligible. The burlap should never be allowed to dry out and thus the concrete does not lack the necessary water for hydrating in the early periods, a condition which has often existed in the other methods of curing concrete roads. I consider that this is one of the greatest developments of details, and one which has actually improved the lasting quality of concrete. As soon as the road surface becomes hardened the burlap is rolled up and ready for the next day's work, while the concrete road surface is covered with earth, sprinkled and wet in the usual manner.

Testing Riding Qualities of New Road

Many specifications are now including regulations as to the riding qualities and evenness of the concrete road surface. Ordinarily this cannot be tested until the next day when the concrete has hardened sufficiently to bear one's weight. Recently there has been an appliance invented which consists of an extremely light straight edge, which may be fastened to the end of two handles in order to reach out to the road surface and test the surface before it has become hardened.

Many other experiments have been carried out in the detail of curing concrete pavements, but no definite results have

been obtained. One state has used calcium chloride in solution applied on approximately 1 in. of earth covering. Another method tried has been the covering of the concrete surface with a heavy asphaltic oil. The oil was applied to the road in the proportion of about 6/10 gal. per sq. yd., and in two weeks' curing period the asphalt was peeled off and again used. No definite recommendation is made at the present time in regard to this method.

Oiling Subgrade

Another extraordinary experiment has consisted of the oiling of the subgrade preparatory to the laying of the concrete pavement, the object being to prevent mud during the light showers. It has been found that when the light truck is used this oiling proves to be a considerable advantage, and, no doubt the oil offers some assistance to the stabilization of the subgrade.

Steel Bar Reinforcement

While for a long time it has been customary to use wire fabric in the reinforcement of concrete highways, steel bars are occasionally used, and while there has been no development in regard to the use of this fabric reinforcement, there is, however, a change in the method of using steel bars. The new development consists of making these bars into a mat, consisting approximately of 10 to 14 bars transversely, and about 5 bars longitudinally. The mat is then wired together and handled as sheet reinforcement.

The use of dowels at the transverse construction joint can hardly be considered as new, as this method has been carried on for several years, and found to be very satisfactory in overcoming the tendency of one slab to rise above the other.

Using Fibre Conduits Across Roads

Another method in construction detail is the installation of fibre conduits placed transversely across the road at various intervals, especially through small towns and villages. It is the function of these conduits to provide a means for gas, water and electric wiring to cross the road without making it necessary to break up the pavement.

Bituminous and Brick Developments

In the construction of sheet asphalt surfaces there is a tendency to be more liberal in the grading of sand aggregates, and the use of a lower penetration asphalt. There is also an inclination to use a 3-wheel roller in compacting the sheet asphalt surface. While this is not absolutely new, its use has never been universal.

Another new development is in the combining of a binder course and sheet asphalt surface in the one course, which virtually consists of a stone-filled sheet asphalt; the stone composing from 25 to 60 per cent of the entire surface. When this surface is used no binder course is laid, and the surface is compacted as an ordinary asphaltic concrete.

Recent developments in brick pavements have shown that the vertical fibre brick laid on a concrete base and sand cushion, grouted with a bituminous material is capable of withstanding the ravages of traffic.

"Progressive Type" of Road in North Carolina

The findings of the Subgrade Committee, of which Senator du Pont is Chairman, have shown that the traffic-bearing properties of the pavement depend greatly upon the stability of the subgrades, and that the subgrade can be greatly stabilized by being mixed or covered with a non-capillary material, such as sand, gravel or top soil. This has lead to the development of what, in North Carolina, has been termed the "Progressive Type" road, which consists, first, of the grading of the road and the building of drainage structures, and then surfacing with a non-capillary material, such as gravel, sand clay or top soil, which, in truth, is nothing more than the construction of a subgrade highway for a future constructed hard surface pavement. This can be maintained as a subgrade highway for medium traffic at a reasonable cost, and, when occasion demands, it can serve as a high bearing value subgrade for any type of surface desired. This method of construction means that all previous steps in the construction have been preserved and that the completion of a hard surface road is merely an addition; there being no economic loss whatever, due to the fact that the previous work is incorporated into the completed hard surface road.

I would not consider this paper complete without describing one of the new methods we are trying, and which promises to be very satisfactory in the treatment of constructed subgrade highways, now being utilized as roads, and in the treatment of top soil or sand clay roads.

Many states are situated similarly to North Carolina to the extent of having a large mileage of sand clay top soil, or gravel surfaces.

There has been much experimenting in the attempt to secure a bituminous material which would satisfactorily preserve this type of road surface. It was generally found that any bituminous material sufficiently light to penetrate this surface would have practically no binding qualities, and that any bituminous material sufficiently heavy to have binding qualities would form a mat on the top of the road surface, and soon peel off, due to the dusting of the road surface directly underneath the bituminous covering. The weak point in this treatment was not in the bituminous blanket, but in the contact of the bituminous blanket with the road surface.

North Carolina is attempting to develop a method which will correct this weakness, and provide a contact between the bituminous covering and the road surface. The method consists of softening the road surface by means of sprinkling and then rolling into this surface broken stone or gravel of approximately 1½ ins. in size. After this has become thoroughly imbedded in the top soil or sand clay it is allowed to dry out, and subjected to traffic for a short period, after which it is swept clean by brooming. The road surface now consists of a single layer of crushed stone imbedded in the strong and rigid sand clay or top soil surface, and forms a satisfactory bond of contact for the bituminous material. Thus a sufficiently heavy material to have binding qualities can be applied to this sand clay road, and the layer of broken stone will prevent the dusting up of the road surface directly underneath the bituminous mat. By waterproofing the top soil or sand clay in this manner, a strong pavement is preserved and after the first application of the bituminous material a mat can be built by using various types of pavement. While this method has not been in practice long enough to prove its complete success, the developments show that for a slight expenditure a sand clay or top soil road can be materially improved.

Although road surfaces seem to have already resolved themselves into certain types, unless new materials are found or new treatments of the present materials discovered, the general types of pavements will probably not change to any great extent; nevertheless the constant discovery of weakness and economic extravagances makes it absolutely necessary for highway engineers continually to keep well posted in the new developments in details followed in the construction of modern type pavements.

The foregoing paper was presented before the recent annual convention of the American Association of State Highway Officials.

SUCCESSFUL COMMUNITY HEATING AT ARCADE, NEW YORK, WITH EXHAUST STEAM FROM LIGHTING PLANT

Municipalities or communities having electric light or other plants in which steam is used as power would profit by studying the experience of Arcade, a village of 1,300 in Wyoming county, New York. Arcade has made a success of municipal ownership and operation of two public utilities. While the plants are not large as municipal enterprises go, their growth and development show in a striking way what can be done along this line by a community, large or small, proceeding carefully and acting upon sound business principles.

Exhaust Steam Utilized

The utilities are lighting and heating. Lighting is placed first because in this instance it was an electric lighting plant that was first put into operation, a heating plant being added to utilize the steam back of the lighting plant after it has performed its initial function of generating electric current. For many years this steam was waste, puffing into white clouds of vapor through the roof—a familiar sight in many like plants.

The utilization of this waste, placing the nose of the exhaust pipe underground and distributing the steam to serve virtually every business place in the village, is the achievement that reflects greatest credit upon the village boards and the administration of the electric light system, now the combined light and heat plant of Arcade.

Advantages of Combined Lighting and Heating Plants

The dual plant not only conserves several hundred tons of coal during every winter month, but also accomplishes these important things:

Reduces the fire hazard in individual

buildings and thus lowers the insurance rate.

Does away with the dust and dirt incident to the operation of basement heating plants in stores and office buildings.

Relieves the community of anxiety over a shortage of coal for domestic consumption.

Furnishes steam heat to customers at a cost about equal to what they formerly paid for fuel, not counting the labor involved in individual heating appliances.

Finally, and this is more important to the engineering than to the lay mind, the condensation is brought back from the street mains to the electric plant through a return pipe, furnishing distilled water for the boilers to the extent of 75 per cent. of the total amount of water used.

The Lighting Plant

The electric light plant was built about thirteen years ago. Like many other enterprises of the sort, it took a good many years to put it on a paying basis, giving the consumers ample current at a rate equal to or lower than it would be furnished by a corporation seeking to pay dividends to stockholders. But it was accomplished. Five years ago it reached the self-sustaining stage. It now furnishes current for lighting the villages of Yorkshire, Sandusky and Delevan, all within a radius of five miles of Arcade. Arcade meters and collects in Yorkshire and Sandusky and sells a block of current to the village of Delevan.

One of the difficult problems facing the electric light administration was to get an evenly balanced load over the 24 hours. The first users, of course, brought the peak of the load from early evening until midnight. A knitting mill was induced to install electrical equipment and become a customer of the city and a vigorous campaign of education in the use of things electrical resulted in the installation of a considerable number of electric ranges, irons and other domestic equipment. The result was a fair distribution of load throughout the day and night.

Utilization of Waste Heat Proposed

About this time the question of utilizing the steam exhaust at the electric light plant was revived after lying dormant for several years. L. A. Mason, then in charge of the electric light plant, wanted a survey made. He asked the then village board for an appropriation to pay an engineer to make one. The board was conservative. It was willing to consider a proposal to use the steam for heating the school building, located across the street from the lighting plant, but refused to vote for a survey having in view a general village heating system. That laid the proposition on the table for another year.

As the electric light plant grew and took on new customers at home and in the adjacent villages, it became necessary to install a duplicate boiler system to provide against emergencies. A view of the power plant in shown in Fig. 1. When the plant enlargement proposal was taken up by the village board the heating plant idea was again injected by its supporters, but another deadlock seemed likely to develop. A representative of a steamfitters, supply house who happened to be on the ground in connection with the alterations at the electric light station heard of the situation and volunteered to have one of the firm's engineers make a survey without cost to the community.

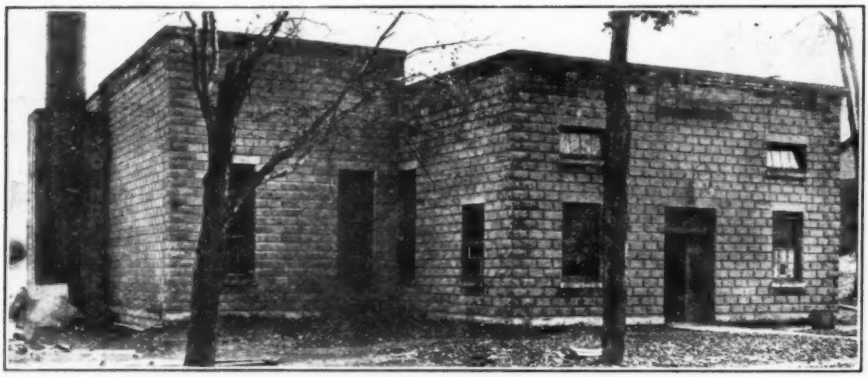

FIG. 1—ELECTRIC LIGHTING POWER PLANT AT ARCADE, N. Y., DIRECTLY ACROSS STREET FROM SCHOOL BUILDINGS AND BLOCK FIRST HEATED BY EXHAUST STEAM FROM THIS 475 B. H. P. PLANT.

His offer was accepted and after the survey was made, a meeting of the business men of the village was called to talk things over. The upshot of it all was that the proposal went to the taxpayers and the board was authorized to issue bonds to the extent of $12,000 for the installation of steam mains on the north side of the main business thoroughfare, which is nearest to the electric light station, see Fig. 2.

Contract Awarded for Heating Mains

The contract for the installation of the steam distributing plant was awarded and work was begun in October, 1920. Weather conditions were not conducive to rapid progress and it was not until January, 1921, that steam radiators began to take the place of stoves, furnaces and individual steam-heating plants in the business blocks on the north side. The first consumers were highly pleased with the service and it was not long before business places on the south side of the street began to ask for an extension of the main.

Influence on School Affairs

The village had voted to spend $100,000 for a new school building, but construction was delayed because of the high bids submitted. The old school, see Fig. 3, a three-story frame structure, had no less than six fires in the basement under various systems of heating, direct, hot air and hot water. They were expensive, inefficient and because of the fire risk, use of the third floor was forbidden by the fire underwriters, compelling the board of education to spend over nine hundred dollars a year for quarters outside the school building.

FIG. 3—FRAME SCHOOL BUILDING TO WHICH STEAM MAINS WERE LAID, TAKING PLACE OF HOT AIR FURNACES.

The Third Floor of this Building is now Available and Used for School Purposes, with Permission of State Inspectors, Due to Introduction of Steam Heating and Removal of Hot Air Furnaces.

Architects for the new building were consulted to find out what sort of Indirect Heating coils were to be used in the proposed new schoolhouse and to learn whether it would be possible to install them in the old building and remove and use them in the new schoolhouse when the time came to build.

FIG. 2—NORTH SIDE OF MAIN STREET, ARCADE, N. Y. ALL BUILDINGS SERVED WITH STEAM FROM CENTRAL PLANT. FIRE HAZARD REMOVED IN THIS ROW OF BUILDINGS.

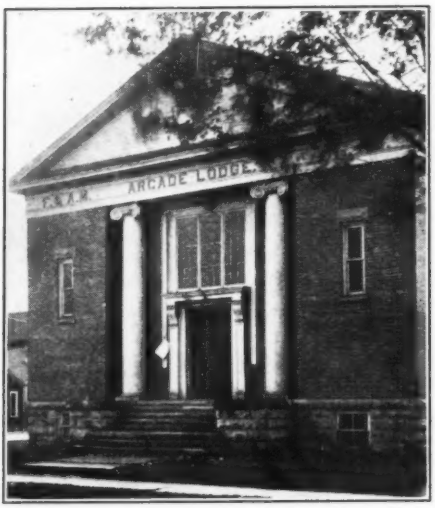

FIG. 4—MASONIC LODGE BUILDING, THE FIRST CONNECTION MADE IN THE SECOND INSTALLATION OF UNDERGROUND STEAM MAINS AT ARCADE, N. Y.

It was found that such a plan was feasible. So the proposal to take care of the south side of Main street, see Fig. 4, was coupled up with the schoolhouse heating plans and the tapayers voted to authorize another bond issue of $12,000 to cover the expense. This year the extension of a main to the south side was completed and another main was carried across the street to the old schoolhouse in which the new heating system will be ready before snow flies. The Hot Air Furnace equipment removed from the school buildings included built-in-boxes with wooden frames for the reception of the pipes. These box frames were found to be very dry, and in some cases charred, so that a fire threatening life and property loss was easily possible.

Last winter partly because of the mild weather only about one-third of the exhaust steam was used. This winter with 24 taps for buildings of all sizes and the schoolhouse, there still will be more than enough from the engine exhaust to furnish first class service.

Heat Available if Lighting Plant is Temporarily Shut Down

Provision has been made to continue the steam heating part of the plant in the event of an accident or any contingency involving a temporary shutdown of the electric light station. A direct feed pipe connects the boilers with the mains through which live steam can be sent when the supply from the exhaust is cut off or runs too low. This direct steam service also will supplement the exhaust flow during extremely cold weather. The

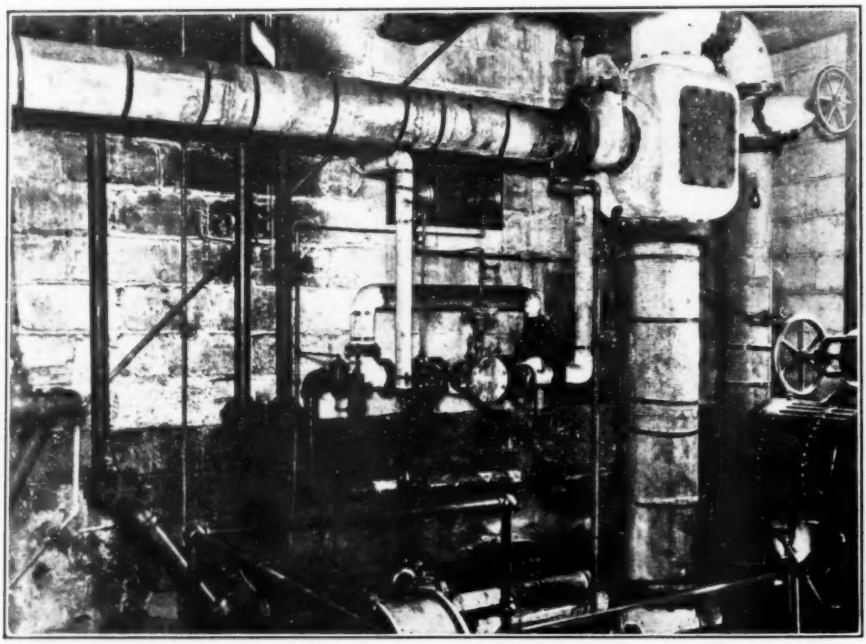

FIG. 5—PIPING REQUIREMENTS IN BOILER PLANT, WITH REGULATING VALVES CONTROLLING HEATING SUPPLY AT ARCADE, N. Y. ALL CONTROL IS AUTOMATIC.

piping requirements which permit of the automatic supply of exhaust or live steam, as may be required, require no extra room, see Fig. 5. Should emergency arise, all steam valves are immediately available to the engineer, being within a few feet of the engine valve.

Financial Aspects

The $24,000 bonds which cover the entire cost of the steam distributing part of the plant carry an interest charge of $1,440 a year. The revenue from the present number of steam service customers is sufficient to pay the interest and retire the bonds at the rate of $2,000 a year. In a few years, therefore, the plant will have paid for itself and become a revenue producer for the municipality, at the same time giving an eminently satisfactory heating service to the entire business part of the village at a cost below what individuals and firms had been paying for fuel. And the school building will be comfortably heated, the fire risk immeasurably reduced and the three floors open for use. This third floor of the frame school building having been idle for a number of years, due to the order of the fire commissioner of the state, it is noteworthy that the cost to the school commissioners for rented premises has, by this introduction of central heating, been entirely eliminated.

Another important result will be the great reduction of fire risk in the business section.

Converting an Objector

Of course the opposition did not die in a day in Arcade. Only recently a well-to-do citizen who did not keep in close touch with municipal affairs blustered into the office, thumped his fist on the desk and declared he was going to call a halt to what he called "reckless expenditure of the village's money on experiments."

"I am asked to pay for something for the benefit and convenience of others," he said.

An executive invited him into the office, had the books brought in and gave him figures to prove that the dual plant had become a tax-producer and not a tax-eater.

"This plant has not called for the investment of one dollar of the taxpayers' money," the executive explained to him. "It is paying as it goes and produces sufficient revenue to retire the bonds the proceeds of which were used for the improvement. All that you have actually done is to loan your credit to float the bond issue."

Mr. Taxpayer went away satisfied and a little prouder of his home town.

Ultimately Arcade's steam plant, using what for years had been a waste product, will produce a revenue of between $5,000 and $5,700 a year for the village treasury, it is estimated, and there will be no long term bonds for future generations to pay.

Patrons Are Well Satisfied

Are Arcade customers of the steam plant satisfied with the results of their venture, both as users and taxpayers? Here is what some of them say about it:

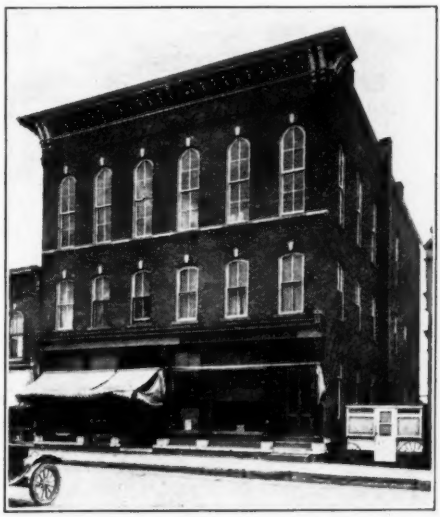

FIG. 6—CITIZENS BANK, ARCADE, N. Y., FIRST BUILDING SERVED WITH STEAM FROM MUNICIPAL PLANT ON NORTH SIDE OF MAIN STREET.

J. H. Smith, cashier, Citizens Bank of Arcade: "Last year we had our banking building, see Fig. 6, connected up with the Exhaust Steam System from the Village Electric Light Plant.

"While we were very sure this system would be a success, we are more than pleased with the system and the way it works. Many said it would never work, but it does and works perfectly and we figure that it saves us money besides doing away with all trouble and dirt from a furnace, and at the same time it is a good money maker for the Village of Arcade.

"Our building (Keystone Block) is 45 x 80 and three stories high above the ground and this is now well heated in all parts of the building.

"The work in putting in this system has been perfect and the contractor seemed to know just how to install the

system and have it right and perfect when completed."

Cottrill & Cottrill, pharmacists: "We have used the municipal heat since last January and are very much pleased with it. It has been perfectly satisfactory in every respect and everyone who has used it cannot speak too highly of it. It is absolutely clean, dustless, fireproof and takes practically no attention. The water heaters used in connection with it are also a great advantage."

B. R. Taber, H. M. Taber & Son, general hardware store: "We were one of the first to have the steam heat installed in our store, and the two upper flats over our store by the Village of Arcade. We used this heat during the winter of 1920 and found to our delight that we had the best heating system anyone could wish for. Without doubht this system will prove profitable to the taxpayers of the village, as this heat is furnished by exhaust steam from the Electric Light Plant. This steam had been a total loss before this heating system was installed. The company who installed this system furnished men who seemed to be experts in their work. The installation was done in a very neat and satisfactory manner."

Frank F. Hammond, Amusu Theater: "I have been a user of the village steam heat for about nine months, to my entire satisfaction. To my mind Arcade is to be congratulated for having established this municipal plant, both from an economic standpoint and for the saving of worry, labor and dirt to the users thereof."

O. T. Wilson, The Wilson Land and Grain Company: "Nearly one year ago, we connected up our heating system in two buildings with the central heating system, one of which buildings is an exclusive office building occupied in part by the postoffice of this village. This building had formerly been heated with a steam system. We connected the same without change in any respect of our previous installation.

"Another block was occupied on the ground floor as stores and the second floor was occupied as four separate flats, which block was formerly heated by a vapor system and was connected with the central heating system without change of installation.

"We also connected up and use steam from the central heating system for the purpose of heating water used for domestic purposes in both of the blocks.

"We are glad to state that now after nearly one year of continual use we are exceedingly well pleased with the plan of heating and the steadiness of the heat gives much greater satisfaction to our tenants than our former method.

"We have had absolutely no complaint from tenants relative to the heat of the water for domestic use.

"In conclusion will say that we have only words of commendation in expression of our feelings upon this subject."

The members of the present village board of Arcade are D. C. Bentley, assistant cashier, Citizens Bank of Arcade; L. S. Bentley, attorney, and Charles E. Buchman. L. S. Bentley is village president. L. A. Mason is clerk of the board.

USING THE STANDARDIZED PAVING BRICK

By W. W. Horner, Chief Engineer Sewers and Paving, City Hall, St. Louis, Mo.

We who have been particularly proud of the growing importance of the industrial engineer have watched with much interest the work of Mr. Hoover's committee, of the American Engineering Council, on the elimination of waste in industry. Some of us have been amused at the information contained in the committee's voluminous report, but have hesitated in anticipating any material accomplishments through these findings. Therefore, to municipal engineers at least, the results of the recent conference, called by the Department of Commerce to consider the possibility of elimination of waste in the paving brick industry through standardization of the product, are most gratifying. At this conference 14 engineering and technical societies met with representatives of the government departments, and of the paving brick industry, and discussed the elimination of excess sizes and varieties of brick.

In his opening address Mr. Hoover stated: "Obviously the consumer is the engineer as he makes the specifications and directs the purchase. The manufacturers are helpless to come to any conclusion of this kind unless they can have the co-operation of the engineers who make the specifications and finally pass upon these matters. * * * This is the first time that we have attempted to bring the groups together, first, the manufacturer, then those who dominate his consumption. So that I am in hope that we can get results." The results obtained were extremely interesting and worthy of detailed study and analysis.

The Standard Varieties

They were aimed at the elimination of waste in this particular industry; that is, in the manufacture of paving brick. In this direction there is no doubt that the accomplishments are of signal value. Briefly, the number of varieties was reduced from 66 to 11, all of which can be made from three sizes of clay column. There remain as accepted standards three depths of brick, that is, 3-in., 3½-in. and 4-in., and two widths, 4-in. and 3½-in. More specifically, we are to have 3-in. brick in 4-in. width in both plain wire cut and with the moulded lug. Also the side wire cut lug brick in a 3½-in. width. The same three styles are provided in the 3½-in. depth, and there is included in addition the repressed brick in the 3½x3½ dimensions. All 4-in. brick are 3½ ins. in width, and include the repressed type, and the side wire cut lug type in both the ordinary paving brick, and in the hillside brick. Also the 3-in. lugless brick may be laid on edge, making a 4-in. depth of brick with a 3-in. width plain side wire cut.

Laying of 3-in. brick flat instead of on edge may require a less number of brick per square yard, but as the prices of brick are governed by the weight it is not a question of the number of brick; furthermore, a small lug on the brick to provide spacing naturally reduces the weight as compared to the weight of a square yard of the lugless type.

With this great achievement secured in the factory end of the paving brick industry, it is interesting from the engineering viewpoint to analyze the use of these brick, that is, to determine their treatment to the best advantage by the other great industry involved, the one which provides brick *pavements* for our streets and roads. In this industry there might occur not only the waste of poor organization methods, but a possibly much greater waste in poor design and construction.

The Depth of Brick

Considering first the depth of brick, the writer feels that the 4-in. depth provides all that is needed for the heaviest traffic, and that the 3½-in. brick may be used to good advantage, that in its use the cost of transportation enters materially into the cost of the finished pavement. The 3-in. brick cannot be so easily disposed of. While it may give satisfactory service for some time under moderate traffic the writer feels that it has inherent defects which should be seriously consfdered by the engineer in designing the pavement. The first of these lies in its large surface area as compared with its depth. (With any type of pavement the bond of the surface must be more insesure with the 3-in. than with the other varieties.) With a 4x8½-in. surface it is absolutely necessary to secure a perfect bedding with the brick, in order that it may not be broken under wheel impact. The mere bedding of the brick under the weight of 5-ton roller will be sufficient to break many of the units before the pavement is completed. The writer has had experiences of this character where 3-in. brick were used on a cushion of screenings or of sand and cement in the sand-monolithic type of pavement, the breakage being so great as to make the actual construction costly.

On account of the thinness of the brick wearing surface the effect of temperature stresses in the cement grouted pavements is extremely destructive, and it would seem highly advisable to consider the 3-in. brick only with bituminous fillers, if at all. The writer wishes to question at this point whether the life of the 3-in. pavements which we are now laying will be sufficient to justify the small saving in first cost involved in the use of this depth of brick. This question may be given emphasis in view of the results of the recent impact tests of the Bureau of Public Roads on pavement slabs.

The Style of Brick to be Used

The next question confronting the engineer is the selection of the style of brick, which are only valuable for a spebrick, which areo nly valuable for a special purpose, he has the choice for his 4-in. surface between the old style repressed brick, with or without lugs, and the side wire cut lug brick.

In making a decision on this point the conclusions of Messrs. Goldbeck and Jackson, of the United States Bureau of Public Roads, as published in "Public Roads" of February, 1919, are of particular interest. "Paving brick with well-formed contact lugs are to be preferred to brick without lugs. Paving brick with square edges are to be preferred to brick with round edges." The City of St. Louis, in investigating the condition of its brick streets in 1914, all of which had been repressed lug brick with cement grout filler, came to the conclusion that among the outstanding defects in these older pavements was the failure of the

grout to adhere to the round edges of the repressed brick, and the spalling off of surface laminations under temperature stresses, and under the wear of steel tire traffic. As a result of this investigation, and in the desire to secure a more satisfactory space for grouting, the repressed brick were eliminated from the St. Louis specifications, and side wire cut lug brick have been used exclusively since that date. This decision seems to be well justified by the report of the accelerated wear tests of the Bureau of Public Roads recently published, in which it was noted that: "The tests would indicate that in resistance to wear the wire cut lug brick ranks above the repressed." And again: "Also the fillers, both asphalt and cement grout, offer considerably more protection and support to the edges of wire cut lug than to those of the repressed brick." That the conclusions here drawn are receiving general acceptance is evident by the decreased production of repressed lug brick, which has fallen from 323,000,000 in 1914 to about 73,000,000 in 1920, as compared to the total production of the two years of 451,000,000 in 1914 and 301,000,000 in 1920.

In the 3½-in. depth the same considerations are involved as between the repressed and the side wire cut lug brick. In this depth, however, the engineer will still have the choice of a 3½-in. vertical fibre lug brick, and of a 3½-in. plain wire cut brick without lugs. The vertical fibre lug brick will possess many of the advantages of the side wire cut lug brick. Its principal disadvantages in comparison are the large uniform lugs which cut the filler space up into small chambers more difficult to fill and to waterproof the foundation, and in the smooth sides which cannot be quite so satisfactory in regard to the adherence of the filler as is the rough side offered by the wire cut lug.

The plain wire cut lugless brick has been the subject of much controversy in recent years. This brick was originally brought out by the Paving Brick Manufacturers' Association in 1919, in what was apparently an attempt at standardization. While thoroughly in accord with the necessity for standardizing on a few types, engineers generally have been unable to approve the choice of this type as a standard. The writer expressed his opinion of this matter in that year, and desires to repeat with emphasis the statement then made. "The lugless brick means a brick with very small and inadequate spaces for joint filling. All our experience has indicated that one of the greatest defects in brick paving has been incomplete joint filling. That this experience is quite general has been indicated by the increasing use of lugs and the employment of other methods for providing a wide, free space for filled penetration." Mr. R. Keith Compton, Chairman of the Baltimore Paving Commission, states that "Lugs are absolutely necessary for the proper flow, no matter what filler is used."

After a thorough investigation the brick committee of the American Society for Municipal Improvements, at the meeting of the Society in Baltimore in October, 1921, recommended a revised specification which provides for regular repressed brick with lugs, for wire cut brick with wire cut lugs, and plain wire cut brick with lugs for cement grout and bituminous filler, but eliminating entirely the type which some manufacturers have been urging as a standard. If Mr. Hoover is correct, that the consumer is the engineer, this decision by the most important committee of engineers having any connection with this matter should be final.

All the consideration applying to the 3½-in. brick apply with equal or greater value to the 3-in. brick, with the possible exception that the 3-in. side wire cut lug brick, being only 3½ ins. in width, presents a more normal relation of surface area to depth than does the 4-in. width. The writer has already expressed his doubt of the ultimate value of the 3-in. brick for paving purposes and would only suggest further that, where used at all, all details of construction should be as nearly ideal as possible, including a proper provision for joint spaces to secure a satisfactory penetration of the filler.

The Bedding Course

Aside from the character of the brick used, a satisfactory brick pavement surface involves also the proper design of the bedding course and filler. For the bedding course three materials are in common use. First, the sand cushion, which was at one time universal, but which has been discarded in a great number of instances. Second, the sand-cement mixture providing the semi-monolithic type of pavement, and, finally, the so-called monolithic type involving the laying of the brick on the wet concrete.

While good pavements have been secured with a sand cushion in some localities, sand in many places has been found unsatisfactory. The sand cushion should never be used except where a satisfactory grade of sand is available, and should certainly not be used with a cement grout filler. On the other extreme, the so-called monolithic type has rarely been found to live up to its name, as temperature stresses in the pavement are inclined to create a movement of the wearing surface, which ultimately breaks the bond. It is to be highly recommended, however, where construction conditions permit of its use economically, for the reason that it is sure to permit of a true bedding of the brick. The sand and cement mixture has been found quite satisfactory. It permits the facility of construction which a sand cushion does not, and with it a smoother surface can be secured than is usually possible with a monolithic type. While it requires careful watching to see that the cushion is not broken while the cement is taking the initial set, it is otherwise simple to handle, and the ultimate strength of the cushion is at times surprisingly high. Of the three types the writer considers it the most valuable in brick paving, regardless of the kind of filler used.

The Choice of Filler

At this time opinion seems to be about equally divided in the choice of filler as between cement grout, bituminous, or bituminous mastic. Where the brick is laid on a strong concrete foundation supported by a well-drained soil, the writer invariably prefers the cement grout as giving to the wearing surface a slab strength over small areas which is of value. If on flexible foundations or on clay soil subject to frost and heaving, a bituminous type of filler is probably a safer choice. When properly handled it is somewhat easier to secure good penetration with a bituminous filler than with cement grout. It has been argued that this ease of penetration with bituminous fillers justifies the omission of lugs, but an examination of recent pavements around the country, and reports from engineers in the technical press, do not bear out this contention. There is apparently a great deal of so-called vertical fiber pavements laid without lugs, in which the filler fails to penetrate materially, and is squeegeed over the surface in the form of an asphaltic or mastic mat. The defect is not apparent in the new pavement, but in the course of a short time, depending on the amount of traffic, this mat breaks up or wears off, and the brick have been found to be loose and the joints largely empty.

The filler in a brick pavement has three functions to perform. First, to hold the brick units solidly in position in order to create and maintain a smooth, continuous pavement layer. Second, to waterproof the pavement and prevent the entrance of moisture into the cushion with consequent disintegration and heaving; and, finally, to protect the edges of the brick from breaking down under traffic. It is evident that properly to carry out these functions the filling of the joints must be complete, and that the bridging of the joints and the creation of the mat of wasted materials which is seen in so many vertical fiber pavements is not good engineering practice.

The writer believes that the lugs heretofore used on both wire cut and repressed brick are somewhat larger than necessary for this purpose, and that in the case of the bituminous filler a ⅛-in. lug will be satisfactory.

In view of the possibilities outlined above it seems advisable to raise the question whether efforts to reduce the cost of the pavement in some cases are not carrying us into a design that is economically unsound and whether the ultimate waste in pavement failures on this account may not be far greater than the waste we have been attempting to eliminate in the standardization of brick. The writer believes that the consumer, in this case the engineering profession, should seriously consider whether conservative specifications such as those of the American Society for Municipal Improvements should not be more strictly adhered to even where the cost involved would be somewhat greater than the first cost of certain of our pavements. If these specifications were adopted quite generally by the profession there would not only be eliminated this possibility of waste, but there would be further elimination in the styles of brick in that the plain wire cut lugless brick in both 3 and 3½-in. depths could be dropped, and that possibly it might ultimately be wise to drop also the other styles of 3-in. brick.

The foregoing paper by Mr. Horner was presented at the recent annual meeting of the American Road Builders' Association.

OVERCOMING CRACKING AND EXPANSION JOINT TROUBLES IN LUCAS COUNTY, OHIO, CONCRETE ROADS

Lucas, County, Ohio, of which Toledo is the county seat, for the past six years has had a concrete road program, initiated primarily by the County Engineer and carried on by public sentiment. The only objection to this type of pavement was the development of cracks which continued to increase in numbers and size as the pavement grew older. How this difficulty was handled by the engineers is described by Mr. E. D. Keil, of the County Engineering Staff, as follows:

To minimize the development of cracks and to keep them from opening, Truscon wire mesh weighing 40 lbs. per 100 sq. ft. was placed 2 ins. below the slab surface. This mesh is manufactured, shipped and placed in flat sheets 6 ft. wide and cut to the desired length, thus eliminating straightening and cutting in the field.

The effect of this steel mesh in the slab is obvious. Cracks were reduced to the minimum; the saving in maintenance alone offsets the cost of installation, which is negligible.

The preservation of the integrity of the pavement by minimizing the number and size of the cracks met with universal approval.

Much trouble had been experienced in getting a smooth finish at the joints as precast or mastic joint was used. Hand finishing was resorted to when the mechanical finishing machines reached the joint.

To overcome this difficulty Truscon dowel contraction joints made of 16-gauge steel were substituted for the mastic joint three years ago. The results were so favorable, the installation so simple and inexpensive that its use is now specified on all Lucas County concrete highways.

The contraction joint extends from the sub-grade through the slab to within 1 in. of the surface. It forms a plane of weakness across the slab so when the concrete contracts, the crack which is bound to develop is straight across the pavement directly above the steel plate, eliminating the unsightly and expensive-to-maintain cracks that formerly ran at random over the pavement following the weakest plane.

The joints are cut to the width of the pavement and to the crown of the metal. The 2-in. dowel in the plate increases its rigidity, making it easy to handle and forms a mechanical lock of the slabs which prevents one slab creeping up on the adjoining slab, thereby eliminating intensified impact pressure always produced by traffic going over an uneven surface, which is so common where other joints are installed.

CONTRACTION JOINT INSTALLATION, DOUGLAS ROAD, LUCAS COUNTY, OHIO.

Concrete placed during the construction season is usually at its maximum expansion at the time it is being placed. Any additional expansion in the dowel jointed pavement after it is laid is deevloped transversely and is effected without fracture, due to the elasticity of the reinforced

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How about the roads in *your* community?

If you have *any* road problems—either construction, maintenance or repairs—put them up *today* to the engineers of our Special Service Department. Their advice, based on wide experience with every type of highway construction, is free for the asking—and it involves no obligation whatever on your part. Please address your letter to our nearest branch.

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concrete. However, the principal tendency is toward contraction, and this is properly cared for along the length of the pavement by contraction joints and across the width of the pavement by the reinforcing steel.

Joints are specified every 50 ft. on pavements 16 to 20 ft. in width and are placed at right angles to the center line of the pavement.

The Lucas County road work was designed and constructed under the supervision of Cecil L. Rood, County Engineer, Toledo, Ohio. Steel contraction joints and reinforcing steel were furnished by the Truscon Steel Co., Youngstown, O. In the carrying out of the road program in Lucas County, as outlined above, there were many awards to contractors known throughout the Middle West. Among them were Warner & McKechnie, Peters Bros., Johnson, Van Wagner & Johnson, Herman Lindsay and Peter Waters.

LAYING SHEET ASPHALT OVER RUTTED ASPHALT BLOCK PAVEMENT AT BRIDGETON, N. J.

By H. T. Macfarland, of Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa.

Utilizing as a sub-base 20-year-old asphalt blocks which had been disrupted by heavy motor traffic and many street openings, Bridgeton, N. J., recently laid modern sheet asphalt pavements on a number of main business thoroughfares in an unusually economical schedule.

By resurfacing the old natural asphalt block wearing surfaces, instead of tearing them up and laying new cement concrete foundations, it is estimated that a saving of approximately $65,000 to the taxpayers was effected.

The success of the resurfacing operations conducted during 1921 has been so pronounced that the general scheme for improvements probably will be followed through 1922.

An investigation of highway conditions in Bridgeton was started in February, 1921, when Remington & Vosbury, of Camden, N. J., were engaged as consulting engineers to study the situation and outline a paving program for 1921 and 1922.

The investigation covered a number of streets in the central district, which had been paved about 20 years ago with bituminous blocks on a gravel base. These blocks had given splendid service for a number of years. In recent years, however, the burden of heavy motor trucks and failure to fill trenches and openings for the installation of water mains, sewers and other underground structures, had resulted in badly rutted and broken pavements.

The bituminous blocks, of natural asphalt, were tested and a large percentage were found to be full of life and in an excellent state of preservation.

A careful study and tests of sub-soil conditions then were made, and as a result of the analysis the engineers decided to salvage the blocks to use as a sub-base for wearing surfaces of 2-in. Bermudez Sheet Asphalt wearing surfaces.

Along curb lines and trolley tracks, in many instances, it was necessary to take up the bituminous blocks, regrade the subsoil and restore the blocks on a lower plane to make room for the 2-in. wearing surface.

After the blocks had been placed on the proper grade, the surface was carefully swept and then painted with emulsified asphalt, applied at the rate of 1/5 gal. to the square yard. This paint coat also was applied to the face of the curb, and to the edge of the stringer brick along the trolley track, where the sheet asphalt was to join.

All depressions were filled in with binder, to bring them up to the proper grade. Then the binder course was laid and the sheet asphalt wearing surface put down.

Bermudez Lake Asphalt was used with a carefully selected and proportioned grading of sand and limestone dust.

The sheet asphalt surface was laid at a cost of $1.86 per sq. yd. The binder was furnished in place by the ton, a unit price being established per ton for trap rock and a unit price per gallon for the native lake asphalt. There were 25,670 sq. yds. of sheet asphalt surface laid in Bridgeton.

The work was performed under the supervision of the engineers, and the Highway Committee of City Council, William B. Holmes, Chairman, and William T. Lanning. A. H. Lupton was the Commissioner of Streets. The contractors were the E. Riley Mixner Co., of Goshen, N. J.

The entire resurfacing operation in Bridgeton was completed in 46 working days. Upon its completion, Council unanimously approved the work, and it is expected the program for 1922 will be followed without digression.

WATER WORKS SECTION

UNDERGROUND VS. SURFACE WATER SUPPLIES WITH SPECIAL REFERENCE TO WAUSEON, OHIO

By W. J. Sherman, Consulting Engineer, 618 The Nasby, Toledo, Ohio.

American water works construction received its first great impetus with the discovery that water works bonds were a good investment.

Forty years ago the advertising pages of the magazines carried many invitations to the investing public to purchase securities of this class. Bond houses specializing in water works bonds, were to be found in all the Eastern cities. New England seemed to be the most fertile field for their sale, with Boston as head quarters for their promoters.

The writer recalls one alluring advertisement calling attention to the safety and security of this class of investment and the good return to the investor. The fact was emphasized that there had never been a default in the payment of principal or interest with investments of this character.

The rapidly developing Middle West afforded a splendid field for promotion activities and many syndicates were formed for operations there.

Early Conditions in the Water Works Field

Water works franchises were sought and easily obtained in hundreds of the smaller cities or towns of this region, municipally owned plants having already been built in most of the larger cities. Franchises were limited by law usually to 25 or 30 years. The interests of neither the investor nor the public were properly safeguarded, due largely to both the inexperience of promoters and the representatives of the public. The fruitful sources of future troubles were in many instances overlooked. A 25-year franchise seemed to provide for a long time in the future. The fact that bonds would mature and that franchises must be renewed or other provision for safeguarding the bondholders and the water consumers was often disregarded. Sinking funds for retirement of bonds were seldom provided for. Provision for a bountiful supply of pure and wholesome water was usually written into the contract, but in many instances was not complied with.

The demands upon the new plant, serving a small population were easily met. Small pumping units and small pipe lines were able to satisfy all the early requirements. Working capital to meet plant demands from time to time and new capital to cover plant extensions, additional or better water supply, water filtration and the like were almost invariably unprovided.

The natural result was a growing dissatisfaction on the part of the public with plant ownership and plant operation under private franchises. In recent years franchise renewals have been difficult to obtain and private water works bond issues have been practically unsaleable.

Today municipal ownership of water works is more in favor than ever before, notwithstanding the fact that there is

PUMPING BASIN AND LOW SERVICE STATION, WAUSEON, OHIO, WATER WORKS.

very little real efficiency in public management.

The promoters of the early water works naturally sought a water supply of minimum initial cost for construction profits were more alluring than the successful operation of the plant in the future. The choice lay between lakes, perennial streams, impounding reservoirs and deep or shallow wells.

In a single middle western state possessing all of these sources of water supply, more than 60 per cent of the water works plants depend upon deep or shallow wells, in other words upon a ground water supply.

With the increase in population has come the pollution of the lakes, streams and other surface water supplies and the gradual lowering of ground water level and increased unreliability of underground supplies. The former difficulty has been and is being met by filtration and the latter by the progressive abandonment of underground sources of water supply in favor of surface water.

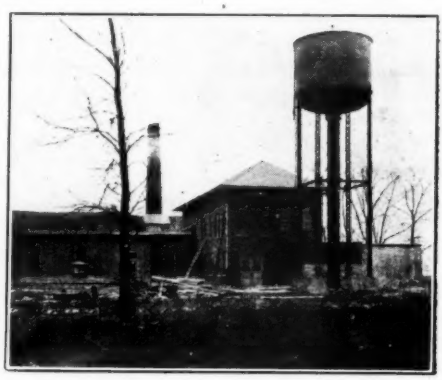
Experience at Wauseon

It is concerning the experiences of an Ohio town with deep wells as a source of water supply that we are writing in this article.

3,000. Her municipally owned water 3,000. Her municipal owned water works were built nearly 30 years ago. The location chosen was about 2 miles south of the town where the D., T. & I. R. R. crosses a supposedly dependable underground water-bearing gravel deposit. Wells were drilled to a depth of about 220 ft., a neat brick pumping station was constructed, duplicate boilers, pumps and clear wells or pumping basins were provided.

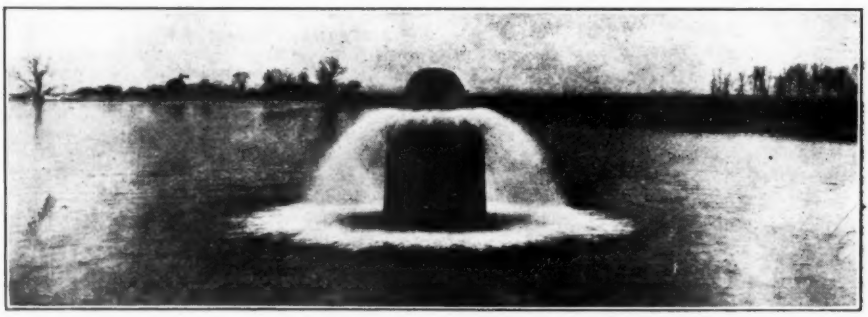
In the early days of the plant the water level in the wells stood near the surface of the ground, but as the years passed, the underground water in this territory in common with practically all the adjacent territory, gradually fell to a lower level, until one day about two years ago, the supply became entirely exhausted, and the town was without water.

This serious condition fortunately developed at a time of the year when most of the surface ditches and small streams were running full. The public fire engine was immediately commandeered and put into commission, feeding the pipe lines of the system through a hydrant, located conveniently near a small ditch, which runs through the outskirts of the town, while preparations for a somewhat more dependable and economic supply were made. A motor-driven pumping unit was located on the banks of the so-called Big Ditch some 3,000 ft. southwest of the old water works station, from which the electric power was obtained.



WASH WATER TANK AND NEW FILTER HOUSE ADJOINING OLD PUMPING STATION, WAUSEON, OHIO, WATER WORKS.

This complete fall-down of the municipal water works was naturally a surprise and distinct shock to most of the people of Wauseon, but within a reasonably short time they authorized a bond issue of



VIEW OF 60,000,000 GAL. RESERVOIR, WAUSEON, OHIO, WATER WORKS.

$170,000 for a new water supply.. This was the maximum amount permissible without exceeding legal limitations and represented additional indebtedness of nearly $60 per capita.

The really difficult problem confronting the engineers for the town was to develop a water supply within the limit of the funds available and satisfactory in all respects, first to the engineers themselves; second, to the Board of Trustees of Public Affairs, which had the water works in charge, and third, and not least, by any means, to the State Department of Health, which possessed the final veto power.

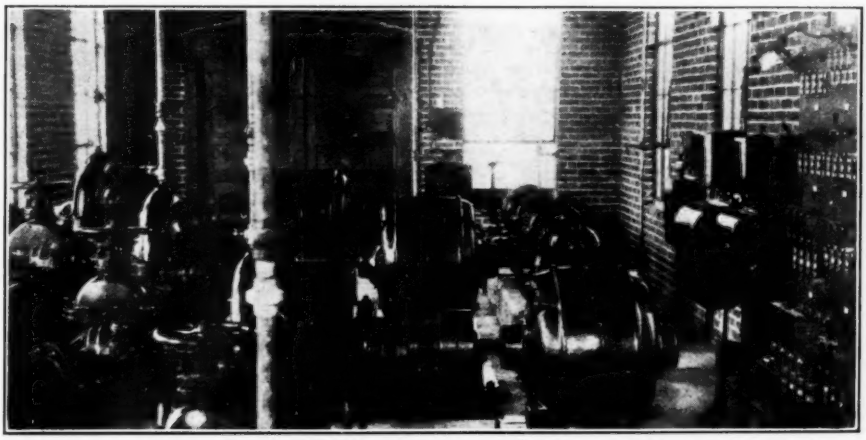
At the outset it was agreed that underground sources would not be considered, after the sorry and expensive experience of the past. There were no lakes or perennial streams within a radius of 8 or 10 miles, and the cost of a supply from such a distance was prohibitive. It seemed therefore, that a local or nearby supply must be developed in some manner.

The main drainage of the town was into a small stream, called Turkey Foot Creek, heading near the north corporation and running southeasterly to the Maumee River. A branch of Turkey Foot from the northeast joined the main stream, two miles east of the Court House. The area drained by this branch was about 7 square miles. There was a fairly good site for an 80,000,000-gal. reservoir just above the junction with a main stream. A half mile away this branch was crossed by three railroads, from one of which—an interurban—electric power could be obtained.

At this fairly inviting location, preliminary plans were developed for reservoir, power-house and filter plant, which were acceptable to all of the parties at interest, excepting the farmers above the reservoir site, who feared their drainage might be interrupted. The opposing influence of the farmer on Board, Council and Merchants of this rural town proved finally to be insurmountable, and this location was therefore abandoned for one near the existing pumping station.

A small stream known locally as the Big Ditch, passed near the old station. The drainage basin above had an area of 4.4 square miles. In certain seasons the channel was entirely dry for months at a time, nevertheless the minimum rainfall as recorded was 21.6 ins. With a run-off assumed at 25 per cent we felt that we had a dependable supply of 5.4 ins. or 414,000,000 gals. per annum. The evaporation and other losses reduced these figures to 378,000,000 gals. This provided fairly well for the present consumption of 110,000,000 gals. per annum, and for the estimated future consumption of double that amount. It was planned to retain the old wells for emergency use when and if needed.

A suitable location in the Valley of the Big Ditch was selected and a 60,000,000-gal. earthen reservoir was constructed, after having detoured the channel of the Big Ditch. At right angles to the new channel a pumping basin 300 ft. in length and 20 ft. across the bottom was excavated just outside the north reservoir embankment. The grade of the bottom of this basin being several feet lower than that of the Big Ditch for obvious reasons.



VIEW OF SIX MOTOR DRIVEN ALLIS-CHALMERS CENTRIFUGAL PUMPS IN LOW SERVICE PUMPING STATION OF WAUSEON, OHIO, WATER WORKS.

The pumping station, a neat brick structure, 16x40 ft., was built at the east end of the basin and in it were installed a battery of 6 motor-driven pumps, four to supply the reservoir and two the new filter plant, 3,000 ft. away.

These 6 pumps in the low service pumping station are all of the motor-driven, centrifugal type and of Allis-Chalmers Manufacturing Co. make. The 4 pumps for reservoir supply are 4, 6, 8 and 10-in. sizes, respectively, and the 2 pumps used for filter house supply are each of 4-in. size.

The reservoir pumps are of different sizes to accommodate the various stages of water in the ditch and pumping basin and have an aggregate capacity of about 7,600,000 gals. per day or sufficient to fill the reservoir in eight days of continuous operation.

The reservoir was actually filled in November of last season without difficulty.

The intake well, gate well and drainage well are substantial circular concrete structures. Water enters the base of the intake well and passes up through 20-in. cast iron pipe, overflowing the top of it in an umbrella-shape stream and falling to the concrete roof of the well, where again it spreads out and falls to the water surface of the reservoir. This arrangement gives fairly good areation to the water supply.

Three 16-in. ports admit water to the gate well at different elevations.

The motor-driven pumps serving the filter plant have each a capacity of 400 gals per minute.

The filter plant was built adjoining the old pumping station and housed in a substantial 2-story brick structure, 25x65 ft., and two subsidence basins of concrete, each with a capacity of 70,000 gals., were located adjoining the filter building. Exhaust steam from the old reciprocating pumps and electric generators provides ample heating capacity for the new structure. The two filter units have each a capacity of 375,000 gals. Provision is made for doubling the size of the plant when and if required in the future. Wash water is supplied from an elevated steel tank, having a capacity of 20,000 gals.

The plant was placed in commission in December, 1921, and at this writing is functioning with an efficiency of 99.6 per cent.

A feature of interest in connection with this plant is the cheap fuel available in the shape of natural gas, which flows from the old water wells, now out of commission, but held in reserve as an emergency source of water supply. It is estimated that from 50 to 60 per cent of the fuel required by the boilers, generating steam for the old pumps and for the electric plant comes from these old wells, while coal from the railroad siding furnishes the balance of the fuel required. Natural gas from an old abandoned private well provides in part for the heating of the low service pumping station at the reservoir.

The total cost of the land purchased, the reservoir, low service pumping station, pipe lines, and filter plant complete approximated $140,000.

TERRE HAUTE WATER COMPANY USES MALLEABLE STREET VAULT COVERS TO STAND SHOCKS OF HEAVY TRUCK WHEELS

By Dow R. Gwinn, President and Manager, The Terre Haute Water Works Co., 634 Cherry St., Terre Haute, Ind.

Experience has shown conclusively that a gate valve in water mains in paved streets should be enclosed in a vault, pit or well with iron cover, so that repairs may be made without disturbing the paving. Occasionally, it is necessary to renew the packing in the stuffing box and sometimes a stem is broken while the valve is being closed or opened. The work of packing or making repairs is greatly facilitated if the valve is in a vault, pit or well. Then the tearing up of the paving is obviated.

It has been the policy, for many years, of the Terre Haute Water Works Co., to build brick vaults around valves in the street mains, with grey iron covers. The valves on hydrant branches are used so seldom that the ordinary street valve box is used on them. These vaults or wells have 9-in. brick walls laid in cement mortar; they are 5 ft. 6 ins. deep and 4 ft. 3 ins. inside diameter at the bottom, drawn in to a 22-in. round neck at the top. The first, or bottom course of brick is laid at a level slightly lower than the bottom of the main.

Formerly, and up to 1918, the Terre Haute Water Works Co. used a square grey iron frame and cover with a 21-in. opening; the upper portion of the frame was a flange 5 ins. wide supported by the brick neck of the vault and lying flush with the paving. The cover was ¾-in. thick with two ⅝x2¼-in. diagonal ribs.

The total weight of cover and frame was 224 lbs. The grey iron cover stood up under street traffic until the advent of auto trucks carrying loads of 5 tons and even more. Complaints were received from time to time of the breaking of the grey iron covers and it was thought best to improve upon the design and material.

The matter was taken up with Mr. Robert Koerner, the then City Engineer of Terre Haute, and Mr. Todd Zachary, Manager of the Standard Malleable Castings Co., Terre Haute, Ind. The result was a malleable frame and cover of the design shown herewith.

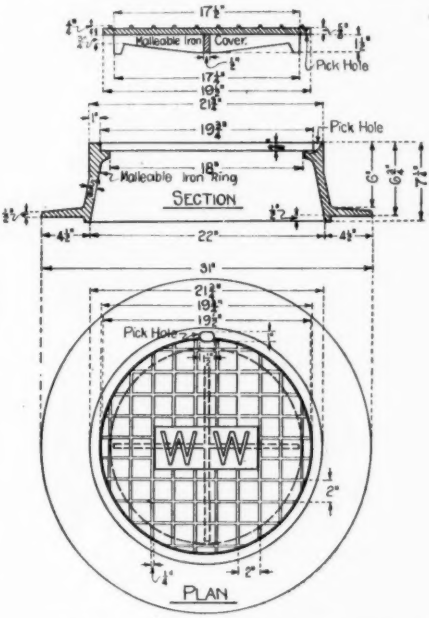
It will be seen that the design provides for the flange below the paving; less brick are required and danger of shocks to the flange from the wheels of trucks are eliminated. There is less surface exposed, although the opening in the frame is the same so far as practical use is concerned. The main advantage, however, lies in the greater tensile strength of malleable castings as compared to the ordinary or grey iron castings. The tensile strength of grey iron castings ranges from 14,000 lbs. to 25,000 lbs., while the minimum for malleable castings is 45,000 lbs.

The weight of the malleable frame and cover here shown is approximately 215 lbs. In December, 1921, the price in quantities was 8½ cents per pound, making the cost about $18.30 each. This price may be slightly lower at this time.

From a publication of the American Malleable Castings Association, Cleveland, Ohio, entitled "Certified Malleable Castings," the following statements are taken:

"The process of making Malleable Iron Castings may be briefly outlined as follows: It consists, first, of melting in an air furnace, open hearth, or electric furnace, a properly proportioned mixture of pig iron, with sprue or scrap castings from some previous heat, and possible additions of steel scrap. The molten metal has a silicon content low enough to force all of the carbon to remain combined in the resultant product and the consequence is that, after the iron has been cast in previously prepared molds, the castings will possess a white fracture with the accompanying hardness and brittleness incident to that condition. Such a material contains all of its carbon in the combined state. Examination of this white or "hard" iron under the microscope reveals the structure, consisting of a white ingredient, cementite, and a dark ingredient consisting of a solid solution of cementite in iron. Second, the subjecting of these castings to a heat treatment in suitably designed ovens where they are heated to redness for several days.

"Through this heat treatment, or "annealing,' the extremely hard compounds of iron and carbon are broken up into two very soft constituents, carbonless



DETAILS OF MALLEABLE IRON VALVE WELL RING AND COVER USED BY TERRE HAUTE WATER WORKS CO.

iron, or ferrite, the most ductile constituent in any iron product, and free carbon. Coincident with this transformation some of the carbon is removed from the castings, both factors serving to convert the hardest possible product into one which is soft yet very tenacious."

"The Association deemed it expedient that the Industry take up the research feature of its product and employed a metallurgical expert to do this work for those concerns which were unable to avail themselves of the services of a metallurgist permanently in their employ. The bars of secrecy were let down and co-operation became the order of the day. Each step in the process was carefully investigated and through visits to the various member companies the faults were eliminated and the product improved a

marked degree. Daily tests are made of the iron produced by each company and a uniformly high quality of output is demanded as the prime qualification for membership..

"Standard ⅝-in. test bars were made daily by each member from his regular heats and submitted to the metallurgist for test."

There is an advantage in Malleable Cast Iron in that while a casting, when subjected to the weather, will almost immediately cover itself with a thin coating of rust, the action of the elements seems to stop there and even after years of service, the weight and other characteristics remain unchanged.

In nearly three years' use of the Malleable casting frame and cover, there has not been one broken, although subject to the shocks incident to the passing over of heavily loaded trucks. On account of a number of small mines located just outside of Terre Haute, a large number of trucks are used for hauling coal to domestic consumers in the city, hence the frames and covers have been given a severe test. The tendency seems to be to enlarge the capacity of trucks and one can hardly suggest the ultimate limit that will be reached. Therefore, the Terre Haute Water Works Company has adopted the policy of replacing all broken valve vault frames and covers made of grey iron castings with malleable castings; for all new valve vaults malleable castings are used exclusively.

In water works practice, only the best material should be used. Some of the trucks in use in Terre Haute are hauling up to 9 tons of coal, including the weight of the truck, 5 tons; this means a total weight of 14 tons. The writer is of the opinion that in specifying frames and covers for valve vaults that malleable castings should be substituted for grey iron castings.

Malleable iron castings are fast replacing grey iron castings where service and strength are required. Records at the Standard Malleable Castings Company for the past year, show that the strength of the malleable iron produced at that plant has an average ultimate strength of 56,750 lbs. per square inch and an elongation of 17.25 per cent. The average ultimate strength of the highest grade of grey iron castings is in the neighborhood of 26,000 lbs. per square inch. This shows that malleable iron is twice as strong as grey iron. Therefore, as to strength and service, a malleable casting properly designed can weigh one-half that of a grey iron casting. This means considerable, both from the engineering standpoint and from the cost of production.

Of course, malleable and grey iron are not made in the same way. Malleable castings undergo a heat treament. Malleable easily absorbs sudden impacts and vibrations and thus is less liable to breaking. A grey iron casting cannot absorb shocks so well because of the ease with which it fractures.

THE EXTRAORDINARY HAZARDS OF METER READING

Consider the meter readers, who, unlike the lilies of the field, toil and sometimes spin, and also reap an astonishing harvest of injuries, says *The Travelers Standard.* At first thought, the reading of water, gas and electric meters appears to be an occupation in which the hazards are negligible. An examination of the accident records of public utilities will show, however, that meter readers are proportionately represented among the list of injured employees.

The meter reader has to use the streets more, perhaps, than any other utility employee. He is therefore subjected more to the hazards of street traffic, and to those associated with icy or otherwise slippery pavements; and eternal vigilance is the price he must pay, to be reasonably assured against injury.

He must next overcome caninė objections to his entrance upon the premises he has to visit. This difficulty is more pronounced in small communities, where family pets are specially prevalent and where they are allowed greater freedom than in urban centers.

Having terrified, overpowered, or beguiled the dog, the meter reader is ready to enter the dwelling, and at this point he encounters another hazard, consisting in the decided contrast between the bright daylight that he is leaving, and the semi-gloom of the basement. This part of a house almost invariably has poor natural lighting, and the artificial facilities usually consist of one electric light or one gas jet, near the furnace. The meter reader seldom stops to make use of these, because he invariably carries an electric flash light. To the householder, the illumination in the basement may appear to be adequate, because he seldom goes directly into the basement from out-of-doors, and so is not subjected to the sharp

contrast in lighting intensities. Furthermore, he is thoroughly familiar with local conditions, and knows, for example, that the third step on the stairs is worn at the edge, and that the fifth step is broken, and that the drain pipe, water pipes, or steam pipes are about forehead-high. He instinctively avoids the stair hazard, and goes about the basement in a bowed if not reverent attitude. A meter reader cannot do his work by instinct, and the obstacles he encounters do not always stimulate reverence. He usually flashes his electric torch along the path he takes, but as the field of illumination is limited, he often discovers overhead obstacles by the simple but unpleasant process of butting into them with his head. He tries to maintain a stooped position, and he means to investigate elevated objects as well as those on the floor; but the welts that he wears on his head show that he is not always successful.

Even though the stair treads are all present and in good condition, the housewife or servant sees no reason why she should not store a basket of potatoes on the basement steps where they will be handy; and a broom, a mop, and a scrup pail are usually present also. Among other things that meter readers have found on poorly-lighted basement stairs may be mentioned cans of syrup, jugs of cider or vinegar, dust pans, clothespins, grape baskets filled with stovepolishing materials, rakes, hoes, pitchforks, and lawn mowers. In fact the stairway easily becomes a catch-all,—a condition hazardous enough to the members of the family, but far more so to the casual visitor.

It would be decidedly impolitic for a public utility representative to criticize the housekeeping, or to point out that pools of water and slimy basement surfaces are unsanitary, though he can with propriety point out to the housewife that the whole family is endangered by using the stairway as a storehouse, or by allowing the basement floor to remain slippery. He seldom does so, however, because he is paid to read meters instead of preaching the gospel of safety. And so he goes on from house to house, knowing that he will meet these same conditions almost everywhere, and realizing that special care is his only safeguard.

Builders and contractors appear to exercise uncanny ingenuity in selecting inaccessible parts of the basement to install public utility meters. We have seen an electric switch-board and meter installed in a coal bin,—or perhaps the coal bin was built around the switch-board. When the bin is empty there is no inconvenience, but with the winter coal supply in, and the meter dials obscured by a coating of coal-dust and ashes, an accurate reading is a problem. We also recall a 2-family house in which the landlord stored the back porch storm inclosures and all the window screens in front of the gas meter. On one visit the meter reader worked half an hour to remove this material, and in doing this he got 3 slivers into his hands, and skinned 1 knuckle.

When the construction of the building permits, the meters are likely to be installed at a considerable elevation. Accurate meter readings are essential, because the utility company is in a good strategic position in case there is a complaint about the bill, provided the check-up reading shows the original one to be correct. Bearing in mind the poor lighting conditions, and the further fact that the dials are often covered with dust, it is plain that the meter man must get close up to the meter, to be sure of his reading. When the meter is installed at an elevation, the reader must find a ladder or improvise a scaffold or platform, out of boxes, barrels, or chairs of the loose-jointed type that are relegated to basements, in order to get a clear view of the meter. Many accidents are caused by such make-shift devices, and there appears to be no remedy available, other than to exert pressure on the proper authorities to change the locations of the meters.

Lack of forethought appears to be the only way to account for placing a laundry stove near a meter, or for locating a meter where the reader is likely to be burned by steam pipes.

Rubbish piles, with the hundred-and-one different things that accumulate in them, often cause accidents to meter readers. Garden implements, clothes racks, baskets, decrepit furniture, and broken boxes with upturned nails ever ready, are a few of the many things the meter man must be on the watch for. After reading the meter he must retrace his steps, and he is then subjected to the same hazards as on the entrance journey —though the danger is now somewhat reduced because he has learned something about the place, and his eyes have become more or less adjusted to the low illumination intensity.

NEW CENTRIFUGAL PUMPING INSTALLATION AT OXFORD, MICH.

By George Champe, Civil Engineer, 610 Nasby Bldg., Toledo, Ohio.

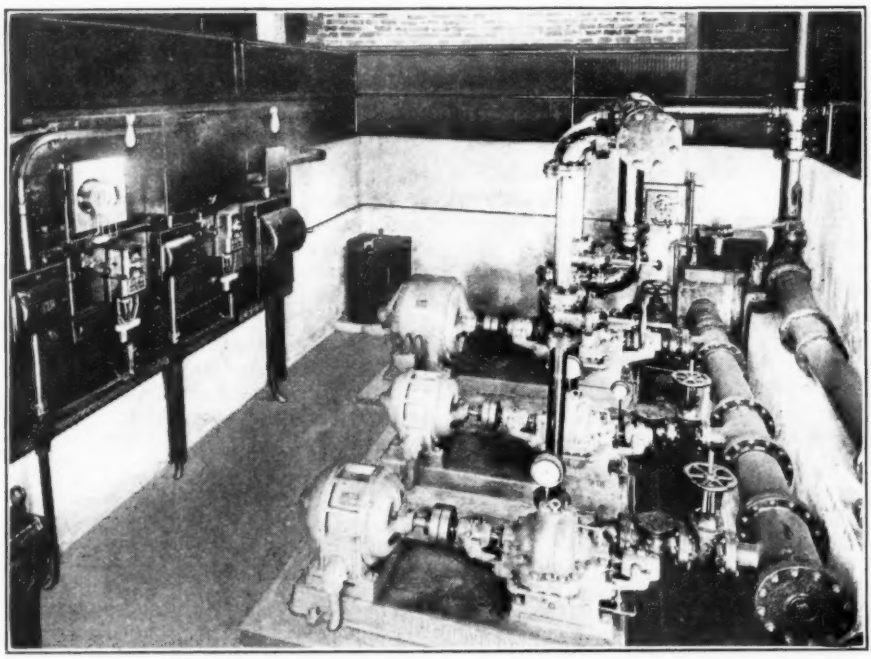
The new centrifugal pumping installation at Oxford, Michigan, is shown in the accompanying view.

The two pumps in the foreground are double suction, 2-stage, centrifugal pumps, with a capacity of 350 G. P. M. against 70 lbs., which is sufficient to fill, to overflowing the steel tank supported on a 100-ft. steel tower and located about three-quarters of a mile from the pump station on high ground in the village. Each pump is driven by a 30 h. p. 3-phase, 60-cycle, 220-volt, alternating current, squirrel cage motor. One pump is ordinarily in service. An altitude gauge, operated by the tank pressure, secures automatic operation of the pump, in service, so that no attendance is required. Previously under steam power operation, three attendants, in shifts, were required, for the 24-hour period.

In the background is seen an Underwriters' fire pump of 1,000 G. P. M. capacity against 100 lbs. manual control, for fire service. This pump is driven by a 100 h. p. slip ring, 3-phase, 60-cycle, 220-volt, alternating current motor.

No difficulty is experienced in the control of the altitude gauge on account of surge in the long pipe line between the pumps and the elevated tank.

From the standpoint of economy the installation is showing a reduction in operation of approximately 50 per cent.



VIEW OF NEW CENTRIFUGAL PUMPING INSTALLATION FOR VILLAGE OF OXFORD, MICH., WHICH REDUCES OPERATING EXPENSES 50 PERCENT.

"SHOOTING" WELLS TO INCREASE THE FLOW OF WATER

By S. R. Russell, C. E., Technical Representative, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

(Editor's Note: The shooting of oil wells, by exploding a charge of nitroglycerin in the well to increase the flow of oil, is a common practice throughout the oil fields. Experienced blasters, with the necessary explosives and accessories, are employed by the oil operators and the methods of oil-well shooting are pretty well established. We are glad to present herewith an article by a technical expert on the shooting of water wells as published in The du Pont Magazine for November-December, 1921.)

Within recent years explosives have come into use for increasing the flow of

drilled water wells. The methods of blasting drilled water wells are much the same as those employed in the oil fields, but the desirability of blasting such a well should first be determined by careful study of its location, its drilling record, and the water supply it is designed to draw upon. While oil wells are usually located in segregated districts at some distance from a town, the drilled water well may be near a farm-house, in the town itself, or even, as in one case concerning which we were consulted, in the cellar of a metropolitan hotel. Whether it is safe to blast depends largely upon the proximity to buildings and the depth of the well. If the well is in a city close to or within large buildings, it may be dangerous to blast, lest the shattering of the rock underground weaken the foundations of the buildings, or flying fragments of rock do damage above ground. If the well is shallow, any risk there may be of injury to surrounding property is increased. However, wells within a few feet of houses have been blasted without the slightest damage and it is probably safe to say that if the size of the charge is proportioned to the depth of the well and the work is carefully done, blasting can be carried out in most places with little risk.

Factors to Be Considered

Whether it will be profitable to blast a drilled water well depends upon the quantity of water in the earth or rock surrounding the borehole, and the character of the formation. Just as it is a fallacy to suppose that there is plenty of water in the earth at any point if one only goes deep enough, it is unjustifiable to expect that blasting a dry drilled well will always make it yield water. Underground waters existing at varying depths, in varying quantities, and in varying degrees of accessibility determined by the climate of the region, the conformation of the surface, and the structure of the earth's crust. That portion of the rainfall which does not immediately evaporate or run off into surface streams sinks into the ground. A small part of it is retained by capillary attraction in the surface soil to be later returned to the atmosphere through direct evaporation or through plants, but the greater part seeps downward into deeper layers of soil or rock, often completely saturating them. The water in this saturated zone is called the ground water and is the great source of supply for lakes, springs and wells. Like surface water, although much more slowly, it is in constant movement from higher to lower levels, flowing evenly through layers of sand or gravel confined by relatively impervious strata, or in rock strata, trickling through the pores of the rock and along joint cracks, bedding planes, solution channels and other crevices. When the water bearing strata strike the surface, as often happens along hillsides or in valley bottoms, the water issues as a spring or forms a lake. It is, of course, to this ground water that wells are drilled. The United tSates Geological Survey has made studies of underground water supply in most sections of the country and can furnish maps and other information concerning the depth, abundance and composition of underground waters and the character of both the water-bearing strata and the strata between them and the surface which will be found of great value alike in selecting the well location and drilling the hole and in blasting to increase the flow of water.

Wells in Sand or Gravel

If a well is sunk into sand or gravel it generally produces water in direct proportion, first, to the quantity carried by the strata, as the water moves freely through all portions of such material, and second, to the angle of the strata, the steeper the dip of the water-bearing strata toward the bottom of the hole, the greater always the pressure and, consequently, the rapidity wtih which the water will rise in the hole. Firing a blast at the bottom of a well in sand or gravel would have practically no effect on the flow of the well; the sand or gravel would simply settle back after the explosion into its original place in the porous mass.

Wells in Water-Bearing Rock

If sunk into water-bearing rock, however, a well may draw only from the particular pores or crevices which it intersects and their tributary pores and fissures, and thus secure only a relatively small portion of the water carried by the whole stratum at that point. If passages could be opened into the borehole from the whole area of the surrounding rock, the flow of the well would be immediately increased. Here, therefore, is the function of explosives, for a heavy charge fired at the bottom of the well would increase the sectional area of the hole, making a collecting cavity for water, and would open up radiating fissures throughout a considerable area of the enclosing rock.

The methods of blasting drilled water wells are derived directly from oil-well shooting. The explosive is usually placed at the bottom of the hole. If a record of the hole has been kept by the driller, as should always be done, showing the kinds of material encountered in drilling, the depth and thickness of each successive layer and the point or points at which a water-bearing stratum was struck, this should be consulted by the blaster before deciding the location of the charge. It sometimes happens that a hole is drilled through a water-bearing area into a lower dry area and in such a case the shot should be fired, not at the

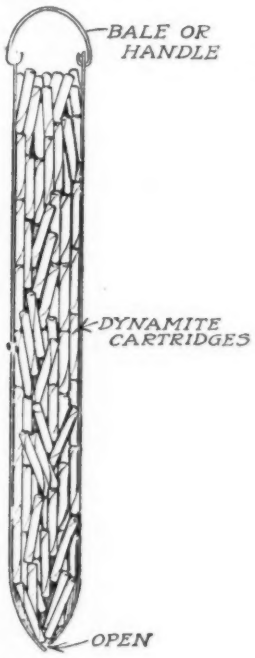


FIG. 1

bottom of the well, but at the level of the water-bearing rock.

The Explosive

Inasmuch as the greatest possible fracturing of the rock is desired, it is advisable to use a quick, powerful explosive and a heavy charge. The best explosive for the purpose is probably Du Pont Solidified Nitroglycerin, but, if this is not obtainable locally, Du Pont 60 per cent Straight Dynamite will also do satisfactory work, provided the column of water which may be standing in the well is not over 200 ft. high. The exact size of the charge is governed by the depth of the well, the nature of the rock to be blasted, and the proximity to buildings. For a well 100 ft. deep an efficient and safe charge would be from 100 to 200 lbs. of Solidified Nitroglycerin or from 150 to 300 lbs. of 60 per cent Straight Dynamite. For every additional 100 ft. this loading could be increased by about 100 lbs.

Seating the Charge

The cartridges are carefully packed in a cylindrical shell (Fig. 1), ranging usually from 3 to 5 ft. in length, made of tin or

FIG. 2

galvanized iron drawn out to a point at the lower end to prevent it from catching in its descent down the hole, open at the upper end and provided with a wire handle or bail. Such a container can be easily made from an ordinary stovepipe. It should always be at least an inch smaller in diameter than the borehole. If there is standing water in the hole, as is usually the case, and the hole is of considerable depth, there should be an opening in the lower end of the shell, as shown in the illustration, so that the water may pass through the shell and equalize the pressure on the explosive.

When the shell is loaded, the bail is placed over a special hook (Fig. 2) on the end of a stout line and is slowly lowered down the hole. By a few motions of the line the hook can then be freed and drawn up. In shooting a very deep well, several shells may be necessary to hold the required charge. If so, they can be lowered successively and one allowed to rest on another. In case a charge is to be located at some distance up the hole instead of at the bottom, a shell provided with an anchor tip is used, that is, a tube about 1¼ ins. in diameter projecting a few inches from the lower end. A tin pipe long enough to reach to the bottom of the well is securely fitted over this tip

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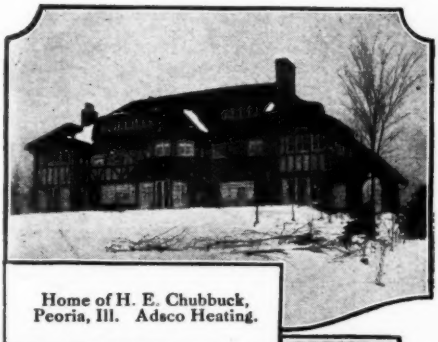

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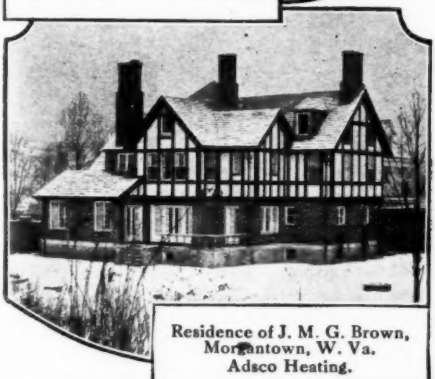

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and lowered into the hole ahead of the shell to serve as an anchor for it.

Exploding the Charge

The charge being seated, the next step is to explode it. This can be done by either the jack-squib (Fig. 3) or the electric squib (Fig. 4). both devised originally for oil-well shooting.

The jack-squib consists of galvanized pipe about 2 ins. in diameter and 36 ins.

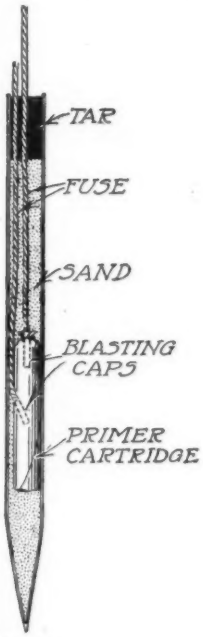


FIG 3

in length, pointed at the lower end, which is filled as follows: Sand is poured into the pipe to a depth of about 6 ins.; a cartridge of 60 per cent Straight Dynamite, primed with two No. 8 blasting caps and two fuses, is seated on the sand, and more sand is poured in until it fills the space around the cartridge and covers it to within 4 ins. of the top of the pipe. This remaining space is then filled with thick tar. This remaining space is then filled with a thick tar. As soon as the squib is prepared, both fuses are lighted, two being used in case one should fail, and the squib is dropped into the hole point down. The length of the fuse should be so calculated that the squib will explode about the time it strikes the charge and thus detonate it.

The electric squib of the oil-well shooter, which should not be confused with the Du Pont Electric Squib, is similar in construction to the jack-squib, but shorter and larger in diameter with a less sharply pointed end. It is usually about 5 ins. in diameter and 20 ins. long. It is filled to a depth of about 6 ins. with sand and then a primer charge consisting of from one to three cartridges of 60 per cent Straight Dynamite is placed in the sand, one of the cartridges having been previously primed with a No. 8 Submarine Electric Blasting Cap. To the wires of this cap, at a point that will come well within the squib shell, are spliced No. 14-gauge copper wires long enough to reach to the bottom of the hole, and the splices are well taped. The remaining space is filled with sand topped with a layer of tar. This squib is carefully lowered by the wires until it rests upon the charge and is then fired by means of an electric blasting machine.

If the well has struck water there will probably be some standing water in the hole. Every foot of water in the hole exerts a pressure of 0.434 lbs. per 100 ft. high over a charge of explosives exerts a pressure of 43.4 lbs. on every sq. in. of the area of the charge. It is this pressure which makes it necessary to protect the detonator from moisture by placing it in a sand-filled and tar-sealed metal shell. As the pressure may

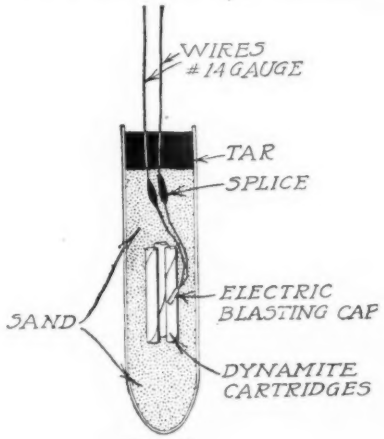
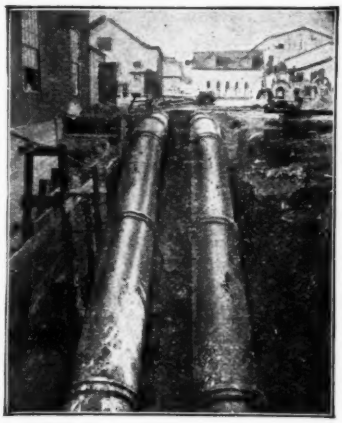


FIG. 4

tend to force out the nitroglycerin from the cartridges, it is important to fire the shot as quickly as possible after loading. All preliminary preparations such as removing objects within danger and notifying people should be completed before the explosive is lowered into the hole so that no time need be lost thereafter.

Effects of Blasting on the Well Casing

Most drilled wells contain a casing throughout a part or the whole of their



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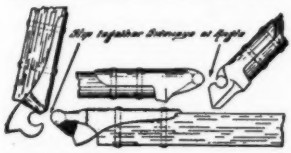

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depth; that is, a closely fitting iron pipe which has been inserted either to prevent sand, gravel or shale walls of the bore hole from caving or to shut off from the well seepage from water-bearing strata nearer the surface than the strata being drawn upon, which is apt to be polluted with organic matter. Exploding a heavy charge at the bottom of the well is likely to damage this casing, either blowing it out in fragments, which may do harm if allowed to fly into the air, or causing it to collapse within the borehole, or splitting it longitudinally along the seam.

To prevent the casing from flying into the air it is well to build a heavy grill work over the mouth of the hole. This should be securely anchored to the ground. It is hardly possible to prevent splitting the casing but this is not necessarily a serious result, for a casing that is merely split can easily be pulled out and replaced.

If the casing collapses, however, it is more difficult to remove. In a well 300 or 400 ft. deep there is less likelihood that the casing will be blown out or split than in a shallower well, but there is danger of collapse whatever the depth of the well. To prevent the casing from collapsing, the hole should be either full of water to the top or empty of water for 50 ft. below the bottom of the casing. This last would mean that the hole was cased through only a part of its length and that the explosive charge was seated at least 50 ft. below the casing. Suppose, for example, a well 100 ft. deep containing 50 ft. of casing from the surface down and 75 ft. of water. The explosion of the charge would probably cause the casing to collapse at the surface of the water. If the top of the water column was a few inches or a few feet below the casing, the collapse would probably occur at the bottom of the casing. If, however, the water was 50 ft. below it, there would probably be no collapse at all. So it is advisable before firing either to fill the hole full of water or to bale it out to a point 50 ft. below the bottom of the casing.

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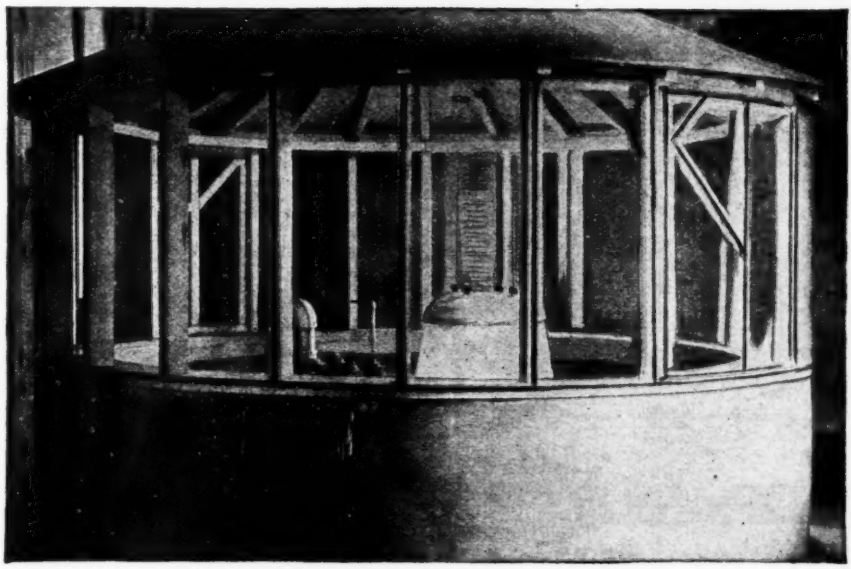
Their report shows that there were 1,200 service connections thawed out, also many hydrants. The service connections were all successfully and rapidly thawed out by the thawing set in from 5 minutes to 15 minutes of thawing operation, the average being less than 10 minutes each, and the average cost of thawing each service pipe being $2.83. Whereas, in other years the old method required three to four men to dig a hole, thaw out and refill the hole at an average cost of $17.50 each, the saving on each service pipe thaw being $14.67 average. A material advantage also is that the street is not disturbed.

On the above basis the city made a direct saving of about $18,000 in a single season with the further advantage of being equipped to do the service in a matter of a few hours instead of a long wait of sometimes days, as before, with the recurrent trouble and disadvantage of not having water over this long period. On account of the success of the first set the city obtained another to enable quick service all over the city.

Operation is taken care of by motor truck driver and helper. The outfit is manufactured by the Auto Engine Works, St. Paul, Minn.



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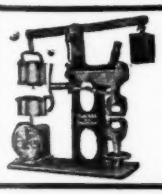

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Construction News and Equipment

STEAM SHOVEL AND DRAGLINE COLLABORATE ON HEAVY SEWER EXCAVATION IN DETROIT

(Editor's Note: The use of steam shovels on sewer trenching is a familiar process and the same may be said of the dragline, but here is a case where the two types of equipment were used together, each performing the work for which it is best fitted. The machines supplemented each other very successfully.)

The dragline had been chosen to do the excavating on heavy sewer trenching in Detroit by the contractors, the Gass-Thurston Co., of Detroit, but the bucket would not dig into the hard yellow and blue clay through which the excavation was to be made. The contractors decided to place their 20-ton "B" Erie down in the hole to break the clay and loaded up to the dragline.

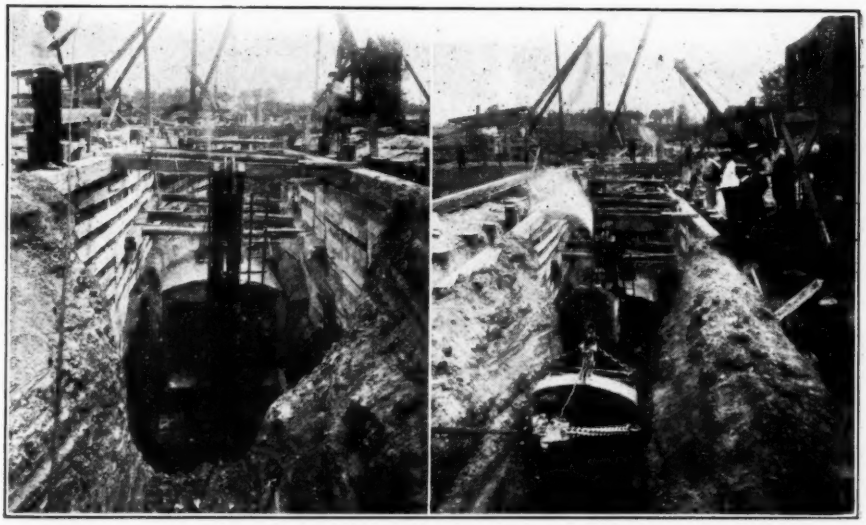
The sewer cut is 16 ft. wide, and varies in depth from 24 to 27 ft. The steam shovel loaded out the material on a bench straight ahead, 15 ft. above the bottom of the cut. The dragline machine then swung its bucket into the bench and removed the loose material, as shown by the accompanying views.

Working in this way, an average output of 350 cu. yds. per day was maintained, with about 400 cu. yds. as the best day's work. The speed of the dragline governed the output; as Mr. E. J. Gass, of the Gass-Thurston Company, writes: "The output of the steam shovel is governed by the speed of the dragline. If the shovel were loading out the excavating material direct, its output would be considerably greater."

EQUIPMENT PERFORMANCE ON ILLINOIS ROAD CONSTRUCTION IN 1921

By B. H. Piepeier, Engineer of Construction, Illinois Division of Highways, State House, Springfield, Ill.

Under normal seasonal conditions April is the first month in which pavement can be laid in Illinois, and this was the case in 1921. It is possible to get in approximately 8 months of work in this latitude. Considering the delays due to weather conditions and other causes, the maximum



STEAM SHOVEL AND DRAGLINE OPERATE EFFICIENTLY IN CONJUNCTION ON HEAVY SEWER EXCAVATION IN DETROIT.

time that any one mixer can be operated is approximately 120 days.

Out of the 102 independent pavers used in the State during 1921, one 21-E paver was operated 129 days; two were operated 121 days; two, 105 days, and the remainder less than 100 days. Fifty per cent was of the 4-bag or 21-E type. The average for all mixers of this type, considering all jobs and all days on which the mixer was operated, was 371 ft. per day. A few special records were made. In one instance a 28-E paver (9-bag) in 10½ hours laid 1,434 ft. of 16-ft. pavement, or 2,549.3 sq. yds. In another instance, two different contractors on night and day shift, with a 21-E paver (5-bag) laid approximately 2,500 sq. yds. The two contractors making this average also made several weeks' run of 1 mile per week, working double shifts.

Out of the 102 paving mixers operated in Illinois, 20 were charged by means of industrial railroad equipment; 34 by central proportioning plants—truck delivery; 12 central mixing plants—truck delivery; 8 from large storage piles upon the highway, and 28 from materials stored upon the subgrade.

During 1922 the specifications will not permit materials to be dumped on the subgrade.

The tendency of the contractors in the handling of their work in Illinois seems to be towards central proportioning plants with pneumatic-tired truck delivery. The popular mixer seems to be the 21-E, and the popular size truck is either the 1-ton Ford or the 2 or 2½-ton short-wheel base, pneumatic-tired truck.

The use of industrial equipment for the delivery of materials has always proven its economy when topographic conditions were favorable.

The central mixing plant has proven to be both desirable and economical on a number or sections of work, where pneumatic-tired trucks were used and where the maximum haul did not exceed 2½ or 3 miles.

AUSTIN ADDS LINE OF DRUM MIXERS

The Austin Machinery Corporation, Chicago, has just announced another addition to its already extensive array of contractors' equipment—this time in the form of a complete line of popular-priced drum mixers.

Heretofore the Austin Mixers have been of the cube design, the mixing being accomplished without the aid of blades or paddles, simply by throwing the batch from plane to plane with a force varying according to the speed of revolution. This

AN AUSTIN DRUM MIXER.

necessitated materials and construction of unusual strength, which naturally would reflect in the price asked.

In the new drum type mixer, recourse is had to the customary elevating mechanism in the interior. The consequent freedom from unusual strain has enabled the Austin people to save on construction cost and thus to meet the demand for a moderately-priced mixer, equal to every ordinary requisite in the way of volume, rate and quality of output, working life, low maintenance cost, and manageability.

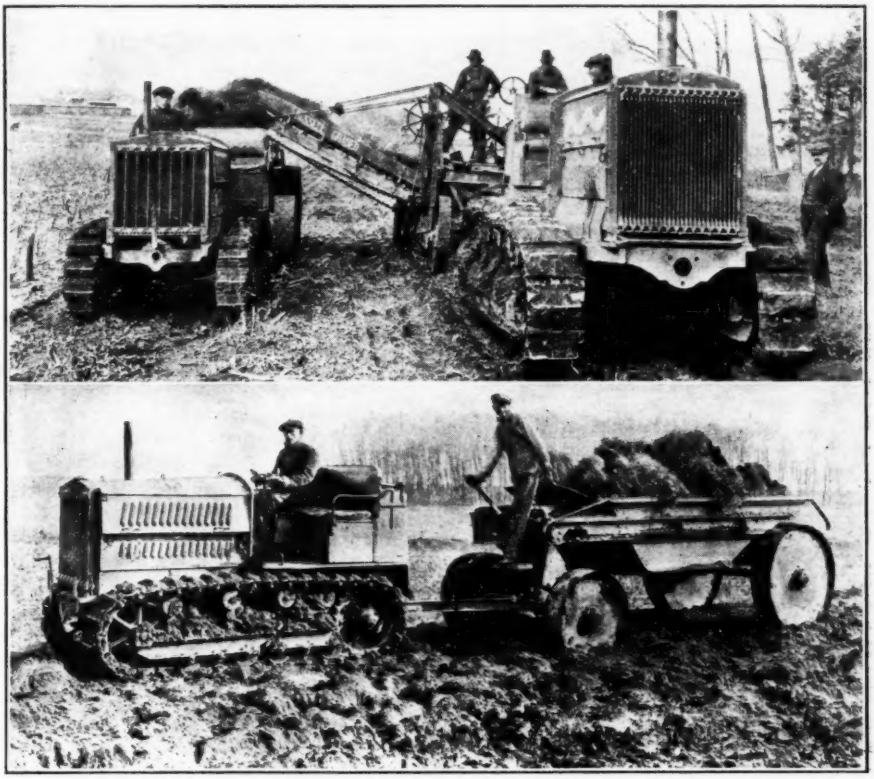
The same principle has been utilized to produce a secondary line of Austin Pavers. The mixers will be supplied in all standard sizes from ½-bag to 2 yds., and the paver in sizes from ½-yd. to 2 yds.

COMPLETELY MOTORIZED DIRT MOVING OUTFIT ON IOWA ROAD JOB

By E. M. Lagron, The Holt Manufacturing Co., Peoria, Ill.

The idea that good roads could not be built without a large corral filled with expensive live stock, and big camp furnishing quarters and rations for labor has been completely refuted during the last few years in many instances, but perhaps no more completely than on the Federal Aid Project No. 103, Delaware County, Iowa, job, which is being built by the Byers-Wilson Construction Co. The project has attracted more than ordinary interest among the highway officials and

contracting firms by reason of the fact that power for the entire operation is supplied by motor units instead of teams, and that there is no surplus of labor. The completely motorized program has revealed a great many economies which were heretofore not thought possible, but which have been conclusively demonstrated by the experience of this contracting firm. Not a horse or mule on the job, and no idle labor makes it an inspiration to witness this particular job and follow the operation chronologically from clearing the right-of-way through to the finished highway. Completeness and thoroughness of the work and the economy and speed which is made possible by the motorized system is self-evident to any one viewing the operation.



FULLY MOTORIZED DIRT MOVING OUTFIT ON IOWA ROAD JOB.
Top: 10-Ton "Caterpillar" Tractor and Russell Elevating Grader and 5-Ton "Caterpillar" with La Plant-Choate 6-Yd. All-Steel Wagon Working in Borrow Pit—Note Heavy Ribbon of Sod. Bottom: 5-Ton "Caterpillar" with 6-Yd. La Plant-Choate All-Steel Wagon. Haul 1,500 Ft.

Clearing

To insure unobstructed tile drainage, 1¼ and 1½ mile stretches of willow trees were pulled by the roots. For the work both the 5 and 10-ton tractors were used. The 10-ton pulled trees 6 ins. to 36 ins. in diameter out by the roots—thus absolutely eliminating future growth. Just as quickly as the trees, stumps and roots were pulled, the cable was changed from the 10-ton to the 5-ton, and the trees dragged off the right-of-way. While the smaller tractor was engaged in this work a second cable was being made fast to another tree, and the 10-ton was preparing to pull it out. In this way not a moment was lost, both tractors were working, and the trees and stumps coming out in quick time. Old bridges, piling and bents which had to give way in the natural march of progress to new concrete structures were likewise quickly and systematically removed.

On clearing, being force account work, the state saved considerable expense when comparing the results in the costs of doing the same work with common hand labor or other tedious slow methods. The contractor is likewise benefited

by being able to keep the road cleared well in advance of their grading operations. As most of this work was done on rainy days or on days immediately following rainy days, which would ordinarily have been time lost (the roads being too wet to work), this contracting firm was able to work nearly 100 per cent of the time. The tractor and crew were kept busy and no "lost time" charged up against profits.

Motorized Dirt Moving

The completely motorized elevating grader outfit with the tractors pulling both the elevating grader and the dump wagon presents many points of interest. Contractors and road officials have carefully watched the progress of the tractor and motor truck in this class of work, and to them the Byers-Wilson Construction Co. job is one of extreme importance, as it represents the solution to a problem which has caused no little worry, and which always has been more or less a source of grief to the dirt mover and road builder.

While the 10-ton was busy with an elevating grader doing the preliminary casting, the 5-ton with a blade grader was preparing the cut for the elevating grader, cutting down side banks, etc. The other 5-tons with either blade graders or wheel scrapers were doing finishing grading, cutting channels, removing heavy boulder or any one of the many odd jobs requiring power and endurance.

To appreciate fully the cost saving element of the completely motorized elevating grader outfit, requires a most careful analysis of time study results. To the casual observer of horse-drawn elevating grader outfits, it would appear that the rig is working to full capacity, This is a case of "snap judgment" and not substantiated by the facts. In the first place this appearance of "being busy" because there is always a team and a 1½-yd. dump wagon waiting to get under the belt is deceiving, as the fact must not be overlooked that it requires 10 to 15 seconds to load each 1½-yd dump wagon, and approximately 15 to 20 seconds are required to change wagons. In this way 40 to 60 per cent of the elevating grader's time is lost.

After exhaustive tests of equipment and material, and most careful scruting of cost sheets, the Byers-Wilson Construction Co. adopted the motorized outfit, but not until they had carefully investigation and realized by close study of the time lost with teams, the possible economy of the new method. The dump wagons which they are using on this job are a new product in the contracting and road building field. These wagons are all steel 6-yd. capacity, bottom dump. They have pressed steel wheels with 10-in. tires and heavy duty bearings.

The 5-ton tractor handles one of these wagons which is loaded by the elevating grader in approximately 45 seconds, and only 10 seconds are required to change wagons under the grader belt. The continuous loading of one 6-yd. wagon instead of several smaller units reduces the lost time factor from 50 to 18 per cent, and the time thus salvaged is utilized to advantage and profit in loading other 6-yd. wagons.

Additional time is saved traveling to the dump with one 6-yd. wagon as compared with teams and 1½-yd. wagons. Teams at their best will average 2¼ miles per hour (few teams can maintain this average day in and day out throughout the season.) The 5-ton tractor, with its multiple speed transmission, permits travel at either 5.7 miles per hour or 3 miles per hour, depending upon the load and ground conditions. The cost charts on the Byers-Wilson job show an average speed for the 5-ton with 6-yd. dump wagons of 4.35 miles per hour—almost twice as fast as teams. During the extreme heat of summer, the teams' efficiency is at low ebb, but the tractors' ability is not lessened.

Making Fills—Five Per cent Settlement

The manner in which the fills were made caused considerable comment, and attracted the attention of all who viewed the job. It was somewhat of a revelation to experienced dirt movers and road builders to realize the complete transition which was being enacted in this work.

The fill was built in layers of 6 ins. to 8 ins. Each 6-yd. load, when dumped, was knocked off and quickly spread with a pair of light mules and Mormon scraper. Each succeeding trip of the tractor and wagon with wide-rimmed wheels, both coming loaded and returning empty, rolled, packed and ironed out the fill until it was even more compact and harder than the old road had been. This was noticeable at once after heavy rains. On the old road, untouched by the grading outfit, traffic sunk in to the hubs; on this new grade just put in, the ruts did not exceed 2 to 5 ins. in depth.

The perfection of the fill was further added to by the action of the tractor grousers or cleats and the Mormon scraper. After rolling and packing by the wagons, the tractors would chew up the surface with their cleats. The surface thus loosened was again spread by the Mormon from the high spots into the low and again the surface was rolled and packed by the wide 10-in. tires of the 6-yd. steel wagon wheels. The result was a fill of uniform density, as solid and compact as if it had been rolled with a heavy steam roller.

At the beginning of this work, grade stakes were set for 10 per cent settlement. After the first 2 miles had been built, the shortage of dirt in the cuts was only additional proof of the rolling and packing of the fills. Accordingly the stakes were thereafter set for only 5 per cent settlement—the engineer being rightly of the opinion that fills put in with the tractor-wagon would have little or no initial settlement. These fills withstood the destroying effects of extremely heavy and frequent rains all fall.

Wintering Cost

Further evidence of the economy of the new system over that of horses and mules is found in the fact that the winter storage of the Byers-Wilson's equipment will cost them approximately $10 per month. This as compared with feed, corral, harness, stable boss and labor charges for the winter can be quickly appreciated.

Asked about future plans, Mr. Wilson says that they have just started, and that his company has conclusively established to its full satisfaction the economy and effectiveness of completely motorizing their outfits.

Contracts Awarded

ROADS AND STREETS.

Ala., Mobile—Hancock Bros., awarded contract for constr. of 4.6 miles Craft Hwy, connect'g Mobile and Chickasha; conc., conc. bridges, etc., at $165,000.

Ark., Pine Bluff—Fred Bennett, awarded contract to pave 36 blks. in Linden St. paving dist., at something over $100,000.

Cal., Avalon, Catalina Island—C. E. Garretson, 508 N. Comstock St., Whittier, awarded contract for impvt. of a number of streets in cent. sect. of town, at about $105,000.

Cal., Sacramento—Henry J. Kaiser, 1st National Bk. Bldg., Oakland, awarded contract for paving with concrete 17.6 miles state hwy. in Riverside Co. bet. Whitewater and Edom, at $298,011; Warren Construction Co., San Francisco, awarded contract for paving with asph. conc. 11.5 miles state hwy. in Riverside Co. bet. Edom and Indio, at $190,781.

Cal., San Bernardino—Henry J. Kaiser Co., San Francisco, awarded contract by St. Hwy. Comn. for bldg. section of state hwy. bet.. Whitewater and Edom at $298,000 and materials furnished by the state, $212,000. Road is to be 5 ins. thick, 16 ft. wide, reinf. conc.; Warren Constr. Co. awarded contract for section from Edom to Idio, asph. conc. 5 ins. thick and 16 ft. wide, at $190,800 and materials, $81,400.

Fla., Gainesville—Barber Fortin Co., Warren, O., awarded contract for constructing 12.6 miles rd., Alachua Co. from Burnett's Lake to Gainesville; Proj. 33; 8-in. compacted base; 3-in. bitum. macadam top, at $285,667.

Fla., Orlando—W. P. McDonald Constr. Co., Lakeland, Fla., awarded contract for constructing 8.59 mi, rd. Orange Co., at $228,040.

Fla., Palatka—Jno. F. Morgan Paving Co., Miami, Fla., awarded contract for constructing 12.8 miles rd. in Putnam Co., No. 18; 8-in. compacted base, 3-in. bitum. macadam top, at $335,830.

Fla., St. Petersburg—B. A. Inglis and C. F. Lytle, Birmingham, Ala., awarded contract for all of state

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road No. 1 betw. Columbia Co. line east to brick road, 42.78 miles, rein. conc., at $986,506; W. P. McDonald Constr. Co., Lakeland, contract for Proj. 13, Orange Co., Plymouth to Mt. Dora, 8.59 miles; 8-in. compacted rock, 3-in. asph., at $228,040; Jno. F. Morgan Paving Co., Miami, contract for Putnam Co. Proj. 18—Cisco to Volusia Co., line, 12.8 miles, 8-in. compacted base, 3-in. bitum. macadam top at $335,830; Barber Fortin Co., Warren, O., contr. for Proj. No. 33, Alachua Co.—Burnett's Lake to Gainesville 12.6 miles, 8-in. bitum. macadam top, at $285,667.

Ida., Lewiston—Fitzgerald & Stalnton, Gt. Falls, Mont., awarded contract for approx. 10 miles road work at $100,000.

Ill., Elmhurst—Pronger & Black, Care E. Hancock, Engr., 2047 Ogden Ave., Chicago, awarded contract for grading, paving and curfing; also constructing sewers, here, at $114,000.

Ill., Springfield—Dept. Pub. Wks. & Bldgs., Div. of Hwys., awarded following contracts: Paving 3.02 mi. Route 12, Sec. 16, Marion Co. to Edwardsville Constr. Co., Edwardsville, at $64,861; 7.22 mi. Route 15, Sec. 16, Jefferson-Wayne Co., 5.59 mi. Route 15, Sec. 17, Wayne Co., 4.98 mi. Route 15, Sec. 18, Wayne Co., W. C. Neill Sons Co., Faribault, Minn., at $143,131, $115,325 and $103,869 respectively; 6.21 mi. Route 28, Sec. 7, Henry-Bureau Co., 5.68 miles Route 28, Sec. 8, Bureau Co., J. J. Dunnegan Constr. Co., Shenandoah, Ia., at $116,945 and $114,930 respectively, 5.79 mi. Route 31, Sect. 3, Adams Co., 5.7 mi. Route 31, Sec. 4, Adams Co. Eiff & Simons, 1013 Bwry., Quincy, $113,718 and $112,913, respectively, 2.09 mi. State Aid Route 10, Sec. E, Iroquois Co., H. Mullen & Sons, Kankakee, at $25,070, grading 7.21 mi. Route 13, Sec. 9-A, Saline Co., 6.32 mi., Sec. 10-A, Gallatin Co. and 6.42 mi. Route 13, Sec. 11-A, Gallatin Co., to L. Rich Constr. Co., Met. Bldg., E. St. Louis, at $18,363, $19,129 and $19,308 respectively; 0.3 mi. F. A. P. 8, Sec. V-3, Macoupin Co., M. R. Deyo & Co., Peoria, at $7,782.

Ind., Indianapolis—Pfizenmayer Constr. Co., Terre Haute, awarded contract for constr. of the Hessong Rd. which is to be a double course 5-mile conc. pavement from Crooked creek to county line, at $191,853; E. F. Smith, Indianapolis, awarded contr. for bridge construction at $21,662 and Standard Paving Co., Anderson, Ind., constr. for Collins Rd. work (1½ miles in length). Collins road work will be one-course conc. constr. Each of the 5 bridges will be rein. conc. Total amount of the contracts awarded is $248,800.

Ia., Clinton—Wright Constr. Co., Des Moines, awarded contract for paving west 17 mi. of Clinton Co. Lincoln Hwy. at $447,716.

Kans., Downs—A. R. Young & Co., Kansas City, Co., awarded contract for paving 25 blocks in resident and business districts, at approx. $160,000.

Ky., Frankfort—State Hwy. Comn., let following contracts for road construction: Langhorn & Langhorn, Huntington, W. Va., contract for constr. of 0.4 mi. road in Boyd Co. on Ashland-Greenup Rd.; brick construction, also contract for constr. of 7.9 mi. road in Greenup Co., bitum. macadam, at $215,603; Louis de Gogets, Lexington, contract for constr. of 3.4 mile road on Lexington-Winchester pike, at $105,000.

La., Jonesboro—J. D. Harvey & Co., Memphis, Tenn., awarded contr. for constr. of 23.8 mi. of road from Winn Co. line to within 3 mi. of Ruston; gravel surf. with conc. culverts and bridges, at $125,583.

Mass., Ogdensburg—A. F. McConville, awarded contract to construct Schoharie County road, 10 miles long, at $266,000.

Minn., Austin—Cameron-Joyce Co., Keokuk, Ia., awarded contract for road construction work in Mower Co. at $109,084. Work includes jobs Nos. 2201, 2202, 2204, 2205, 2206 and 2207. Culverts awarded to H. F. Garbisch, Austin, at $9,474. Conc. monolithic, metal matl. to Lytle Corrugated Culvt. Co., 171 27th Ave., S. E., Minneapolis, at $3,856.

Minn., Duluth—O. R. J. Kapphahn Constr. Co., Chisholm, awarded contr. for paving Woodland Ave., at $100,785.

Mo., St. Joseph—Bryant Constr. Co., Waterloo, Ia., awarded contr. for paving Saxton-Easton Rd. and for resurfacing DeKalb Rd., at $213,775; Land Constr. Co., St. Joseph, awarded contr. for DeKalb road, at $90,008.

Miss., Laurel—Southern Paving Constr. Co., Chattanooga, awarded contract for paving streets here, at $100,000. Vitr. brick will be used.

Miss., Jackson—Dunn Constr. Co., Birmingham, Ala., and Jno. Gerken, Pensacola., awarded contract for paving N. President, N. Congress, Minerva and other streets; conc., at $100,000.

Mo., Jefferson City—Unit Constr. Co., Title Guaranty Bldg., St. Louis, Mo., awarded contract for 7.06 miles May Ferry Rd. FAP 80, at $243,931.

Mo., St. Joseph—Buchanan County and let road contracts as follows: Bryant Paving Co., Waterloo, for paving Saxton-Easton Rd., at $213,775; 7½ miles conc.; Land Constr. Co., St. Joseph, Mo., at $90,008, for resurfacing 10 miles DeKalb Rd.; asph. conc.

Neb., Omaha—Hugh Murphy Constr. Co., 402 Karback Bldg., Omaha, awarded contract for 111,260 sq. yds. conc. paving at $323,714.

N. Y., Malone—Wm. J. Semper, Watertown, awarded contract for constr. of Malone-Duane Center section of state hwy. (7.50 miles) at $233,000. Contract calls for bitum. construction.

N. C., Asheville—Hide & Baxter, awarded contracts for hwys. and bridge constr. work in Wilkes and Jones Cos., at $400,000. 16 miles penetrative macadam in Jones Co. will cost $22,480, and 6 miles reinf. conc. in Wilkes Co., $167,831. (Contractors located in Washington.)

N. C., Gastonia—Simmons Constr. Corp., Charlotte, awarded contract, also Carolina Contracting Co., Chester, S. C., at $800,000 for constr. of 40 miles hard surf. highways; asph. treating surface.

N. C., Raleigh—Following contracts let by N. C. State Hwy. Comn. Geer & Wilson, Rutherfordton, N. C., at $20,350, for constr. of 1 mile waterbound macadam rd. on Route 194, Avery Co. Proj. 801; Hyde & Baxter, Washington, D. C., for constr. of 15.76 miles waterbound macadam rd. with surf. treat. on routes 30 and 303 betw. Trenton and Craven Co. line, at $222,489; structs. to Jno. M. Ogden & Sons, Evington, Va., at $18,583, Jones Co. Proj. 245.

O., Euclid—Gould & Maybach, 823 E. 50th St., Clevelend, awarded contracts for grading, curbing and paving Ashville, Pinehurst, Edgewater, Kenwood, Oakleigh, Woodview, Edgemore, Elbury and Edgehill Sts.; brick, at $201,631; Beverly Hills Dr. to F. B. Stein, Euclid, at $30,571; sewers and water mains in Seabrook, Lakemont and Lamb Aves., Elsemere, Hawthorne and Cambridge Drives, to A. C. Hattendorf, 3601 6th Ave., East Cleveland, A. J. Galvin, Lennox Bldg., Cleveland, and J. B. Lyon, 1852 Rudwick Rd., Cleveland, at $12,707, $14,091 and $5,933, respectively.

O., Warren—V. Olson Contg. Co., 506 Mahoning Bank Bldg., Youngstown, awarded contract for grading, curbing and repaving 3,925 ft. E. Market St.; Metropolitan brick, asph. filler on conc., at $123,612.

Okla., Oklahoma City—State Hwy. Dept. let road contracts as follows: Keliher Constr. Co., Little Rock, Ark., at $92,664 for constructing conc. road from Broken Arrow to Wagoner Co. line; Tibbets & Pleasant, Tulsa, at $91,908, for conc. rd. from Rogers Co. line eastward toward Tulsa.

Okla., Pauls Valley—Standard Paving Co., Tulsa, Okla., awarded contr. for brick paving in Dists. 12, 15 and 16, at $198,000.

Ore., Seaside—J. H. Tilman Co., awarded contract for paving several streets, at $159,000.

Pa., Ebensburg—Anderson Constr. Co., Parnassus, awarded contr. for construction of 32,669 ft. state hwy., Clearfield and Ind. Cos., at $267,452.

Pa., Wilkes-Barre—M. Rosato & Son Co., Inc., W. Scranton, awarded contract for paving hwy. betw. Carbondale and Clifford with reinf. conc., at $193,000.

S. C., Hartsville—Georgia Engrg. Wks., Augusta, Ga., awarded contract to construct 50,000 cu. yds. paving; 40,000 ft. curb and headers, etc., $200,000 available.

S. C., Sumter—Adams-Evans Constr. Co., Jacksonville, Fla., awarded contract to construct 3.1 miles hard surfaced roads on Sumter-Bishopville and Sumter-Manning highways; asph. conc. constr. Total cost, including grading, $151,946.

Tex., Dallas—Scarborough, Smith & Davis, awarded contract for construction of Irving Coppell Rd.; contr. for the surfacing awarded to Texas Rd. Co.; bridges to Andrew Jackson. Total cost of work,

$300,000. Rd. will be built with crush. rock foundation and 1-in. cold mix asph. top from end of conc. rd. in W. Dallas to Irving, abt. 8 miles. From Irving to Sowers to Co. line east of Coppell, 16 mi. rd., constr. will be of gravel.

Tex., Dallas—Miller Constr. Co., Sioux City, Ia., awarded contr. for paving with asph., macadam and gravel surfacing 12.5 miles Preston Rd., and contract for bridges to A. Jackson, 424 Spring Ave. Total cost, $207,581.

Tex., Dallas—Smith Bros. Constr. Co., Dallas, awarded cont. for 12.2 miles asph. pike from city limits of Dallas to Mesquite and from Kaufman Co. line back toward Dallas almost 2 miles, known as East Pike, at $261,719.

Tex., Eastland—Smith Bros., Crockett, awarded contract for constr. of Bankhead Hwy. through Eastland Co., Cisco to Eastland and Ranger, about 21 miles long, at approx. $806,000.

Tex., El Paso—El Paso Bitulithic Co., awarded contract for paving San Eljario Rd., St. Hwy. 33, Job 72-C, 5.54 miles, at $149,668.

Tex., Fredericksburg—Gordon Auvus, Winnsboro, Tex., awarded contr. to construct grading and draing. structs., including bridges, at $100,000.

Tex., Greenville—Board of Permanent Rd. Comrs. Hunt Co., care A. D. Buck, Constr. Supt., awarded contract for grading, surfacing and bridging 9.66 miles St. Hwy. No. 1, F. A. P. 188, at $231,289.

Tex., Hondo—Kuykendall & Shelton, Temple, Tex., awarded contract to construct 13.4 miles gravel rd. with asph. topping, at $226,000.

Utah, Salt Lake City—Moran Paving Co., Felt Bldg., awarded contr. for curbing and guttering Dist. 24, 3rd to 11th Aves., and from H to N Sts., at $149,065.

Va., Williamsburg—S. E. Lee Constr. Co., Emporia, Va., awarded contract for constructing 5.36 miles 18-ft. conc. pavement on State Rd. No. 9, bet. Williamsburg and Lee Hall in James City and Warwick, at $152,219.

Wash., Olympia—Frank Morgan, Buckley, awarded contract for clearing, grading, draining and surfacing with crushed rock, 3 miles Navy Yd. Hwy. bet. Tidewater Crk. and Charleston, Kitsap Co., at $79,584; clearing, grading and surfacing with gravel 3.1 miles, No. Bank Hwy., bet. Cooks and Underwood, to Hans Pederson Constr. Co., Seattle, at $54,993; surfacing with gravel 1 mile of No. Bank Hwy. from Stevenson west, Skamania Co. to Voyle & Lindsay, Stevenson, at $3,827; clearing, grading and draining 2 mi. Ocean Beach Hwy. bet. Naselle and Johnson's Landing, Pacific Co. to Pentillo & Petervo Co., Naselle, at $26,138; clearing, grading, draining and surfacing with gravel 9 miles Olympia Hwy. bet. Beaver and Forks, Clallam Co. to Reinseth & Co., Everett, at $70,732.

W. Va., Charleston—State Road Comn. let following road contracts: Joe Carola, Roncerverte, W. Va., 4.6 mi. Pickaway-Second Crk. Rd., at $87,396, also contr. for 14.5 mi. Rainelle-Rupert Rd., Greenbrier Co., at $269,186; Ederbach Constr. Co., Pomeroy, O., 1.8 mi. West Hamlin-Salt Iock Rd., Lincoln & Cabell Cos., at $161,404; A. L. Nickolich, Fairmont, W. Va., 5 miles Friendly-Bens Run Rd., Tyler Co., Proj. 3080, at $38,573; McClain Constr. Co., Bellaire, O., 0.9 mi. River Rd., Hancock Co., at $30,162; Lookout Constr. Co., Victor, W. Va., for constr. of 3.5 mi. Canvas to Summersville Rd., Nicholas Co., at $31,778; Dayton & Co., Elkins, W. Va., 3 mi. Philippi-Belington Rd., at $23,816 for constr. of 1.1 mi. Junior to Randolph Co. line rd., both Barbour Co., at $72,471 and $28,816 respectively; Smith & Quinn, Parkersburg, W. Va., 2 miles St. Mary's-Grape Island Rd., Pleasants Co., at $15,333; Julian Constr. Co., Glen Jean, W. Va., 5 miles Beckley-Harper Rd., Raleigh Co., at $104,437; W. C. Markle, Clay, 3 miles Clay Courthouse-Hartland Rd., Clay Co., at $45,506; A. C. Grideli Co., Berwyn, 2½ mi. Elizabeth-Palestine Rd. Wirt Co., at $25,072; W. U. & J. T. Gephart, Williamsport, Pa., for constr. of 8.6 mi. Elkins-Burlington Rd., Randolph Co., at $274,000; Geo. L. Pence, Huntington, W. Va., for constr. of 0.6 miles Hamlin-West Hamlin Rd., at $26,238.

SEWERAGE AND SEWAGE TREATMENT

Fla., Monticello—Sullivan, Long & Hagerty, Bessemer, Ala., award. contract to install sewerage system at $34,897.

Ga., Atlanta—McDougald Constr. Co., awarded contract by Citizens' Trust Co. to install sewerage facilities and pave walks and streets in 33-acre tract, at $48,000.

Ill., Bellwood—H. Rees & Son, Quincy, awarded contract for new system of sewers and pump pit, at $125,000.

Ind., Brazil—Foulks Constr. Co., 705 Ohio St., Terre Haute, Ind., awarded contract for sewage treat, plant, Imhoff tanks, sprinkling filters, sludge beds, etc., at $75,000.

Md., Baltimore—Aiello Constr. Co., Knickerbocker Bldg., awarded contract for sewer contracts 48, 185 and 186, at $22,648, $25,929, and $18,031, respectively; Contr. 203-06 to Baltimore Asphalt Blk. & Tile Co., 1320 N. Monroe St., at $32,166.

Mich., Dearborn—J. Porath, 34 McGraw Bldg., Detroit, awarded contract for East Side storm water sewer, 3 ft. 6-in. to 4 ft. 9-in. conc. or brick, at $32,831.

Mich., Detroit—R. D. Baker, 1631 Elmhurst Ave., contr. for lateral sewer 3586, at $25,500; Six Mile Rd. sewer, Sec. 4, to J. A. Mercier, 216 Hammond Bldg., at $290,350.

Minn, Mankato — Hammen & Co., Mankato, awarded contract for sewers and appurts. in Sewer Dist. 3, at $74,915. 385 lin. ft. 18-in. cast iron pipe, 33,541 lin. ft. 8 to 18 ins. V. C. P., 107 hrk. manholes, 84 V. C. P. chimney connections.

Mo, Columbia—C J. McCoy Constr Co., Emporia, Kans., awarded contr. for sewage disposal plant here, complete, at $14,500; sprinkler filter complete, at $47,600; sludge filter complete, $2,000; secondary settling tank, $2,000; conc. bulkhead, $500.

N. J., Newark—Shevlin Engrg. Co., Inc., 110 W. 34th St., New York C., awarded contract for sewage screening machy. installed at Newark Bay Pumping Sta., Port Newark, at $55,660.

N. J., Rutherford—L. B. Harrison & Co., Island Market, Paterson and J. T. White Co., 52 Lexington Ave., Passaic, awarded contracts for Rutherford-Union Branch Intercepting Sewer, here, at $115,287.

N. Y. New York—P. McGovern, 50 E. 42nd St., awarded contract for sewer in 26th St. from bulkhead line of East River to Madison Ave., etc., at $580,391; altering and improving sewer in W. 20th St. to J. Burns, 103 E. 125th St., at $18,355; repairing 15-in. vitr. sewer in East 101st St. to J. V. Timoney Co., 220 E. 201st St., at $2,425.

N. Y., Painted Post—National Constr. Co., Inc., 2218 Chestnut St., Phila., awarded contract for 4½ miles storm and san. sewers, at $63,000.

N. Y., Schenectady—E. P. Edgar, 115 Mohawk St., awarded contract for intercepting sewer, at $76,194; sewers in Bird Pl., Pious Alley, Frank, Hendricks and Bradley Sts., to O. Russo, 942 Crane St., at $2,773.

O., Columbus—Federal Paving Co., 724 Linwood Ave., awarded contr. for 3 miles 15-36 in. joint intercepting sewer in Clinton Dist. 2 at $86,517.

O., Warren—F. George, 1657 Mahoning Ave., Youngstown, awarded contract for laying 3,300 ft. 36-in. segmental blk. and 8,844 ft. 8-24 in. vitr. sewer in South Pine St. and River Ave. outlet, at $63,734.

Okla, Pauls Valley—Gibson & Mitchell, Pauls Valley, awarded contract for constr. of storm sewers, at $45,000.

Okla, Pawhuska—Dahlstrom Impvt. Co., Tulsa, Okla., awarded contr. to constr. sewage disposal plant, at $39,400.

Tex., Breckenridge—McKenzie Constr. Co., San Antonio, Tex., awarded contract to construct 14 miles sewer lines; install disposal plant with 500,000-gal. daily capy. Imhoff tank, at $236,000.

Tex., Magnolia Park (P. O. Houston)—Houston Construction Co. awarded contract to install sewer system; lay 8 to 15 in. mains; construct laterals, at about $500,000.

Wis., Kenosha—Markus Thomson, Kenosha, awarded contract for 10,200 ft. 12 to 48-in. sewers, 250 ft. 6-in. sewer stubs and 40 conc. manholes in Allendale and Lake View subdivs., at $48,460.

Wis., Kenosha—M. Thomson, 1020 Salem Ave., awarded contract for monolithic and vitr. sewers in Lakewood, Durkee, Sherman and Arlington Aves., Exchange and Plymouth Sts., Kenwood, Beverly and Belmont Places, at $45,206.

Wis., Milwaukee—DuPont Engrg. Co., Wilmington, Del., awarded contract for sedimentation and

aeration tanks, in connection with disposal plant on Jones Island, at $726,188.

WATER SUPPLY AND PURIFICATION

Cal., Fullerton—P. H. Ehlers, 1959 N. Raymond Ave., Pasadena, awarded contract for rein. conc. reservoir, at $49,350.

Cal., San Diego—G. E. Engineering Co., Inc., 449 42nd St., New York City, awarded contract for constr. of water, gas, sewer and underground elec. systems at naval hospital, at $52,400.

Ont., Toronto—Gordon Thompson, 40 Jarvis St., Toronto, awarded contract for constr. of 6-in. water mains costing $32,000 for York Twp.

Ind., Marion—C. W. Bailey, Marion, awarded contract for alterations in pumping station and new 5,000,000-gal. steam pump, at $50,000.

Ia., Storm Lake—Pittsburgh-Des Moines Steel Co., Tuttle and SW. 10th, Des Moines, awarded contract for 250,000-gal. steel tank on 100 ft. tower, at $14,250.

Kans., Hoxie—Reed & Wheelock, Clay Center, awarded contract for water work system, 21,270 lin. ft., 4, 6 and 8-in. cast iron pipe, 40,000-gal. tank, 100-ft. tower, etc., at $31,068.

Kans., Marion—Burt & Tripp, Hutchinson, awarded contract for Sec. 1, constr. of bldg. and dam, Sec. 2, pumps and motors and Sec. 3, filter equipt., at $54,997.

Mich., Benton Harbor—Jno. Allmendinger, awarded contract for construction of city new water plant which will include filtr. sys., permitting use of St. Joseph river water. First work to be done is constr. of 2 immense reservoir tanks; one to be a clear water basin holding 770,000 gals. of water, and the other a coagulating tank holding 330,000 gals. The contractor will be paid $5,200 for work of constr., supervision, etc. Net total cost will be about $50,000. Entire work will be under general supervision of Pearse, Greeley & Hansen, Cons. Engrs., Chicago, Ill.

N. C., Rocky Point—J. B. McCrary Engrg. Corp., Atlanta, Ga., awarded contract for extension of water mains and constr. of filter plant; daily capy. 500,000 gals.; purchased two 200-G. P. M. high head upmps and two 200 G. P. M. low head pumps; will install; approx. $30,000. Williamson, Carroll & Saunders, Engrs., National Bank Bldg., Charlottesville, Va.

N. D., Fargo—Norwood Engineering Co., Florence, Mass., awarded contr. for equipping two additional filter units at filtr. plant, at $27,000.

O., Cleveland—Babcock & Wilcox Co., Guardian Bldg., awarded contr. for furnishing 4 water tube boilers at $76,519; Hanford-Riley Stoker Co., Swetland Bldg., contr. for mechanical stokers, at $42,490.

Okla., Broken Bow—Ladd Constr. Co., 716 Scarritt Bldg., Kansas City, Mo., awarded contract for water works system and filtration plant, at $120,000.

Okla., Fairfax—Ajax Constr. Co., Lawton, awarded contract for improving water works, sewers and disposal plant, at $58,776.

Pa., Philadelphia—W. K. Mitchell & Co., 2940 Ellsworth St., awarded contract for piping at Queen's Lane and Larner's Point pumping stations, at $11,833; steel connecting flues and economizers to Phila. Tank & Stack Wks., Phila., at $7,388; general constr. of foundations for Belmont pumping station to Mitchell-Houseworth Co., 30th and Lehigh Aves., at $21,747.

Utah, Salem—F. S. Whitney, Eureka, awarded contract for 8,000-ft. 4-5-in. cast iron gravity flow line, 30,000 ft. 1½-4-in. steel pipe and 75,000-gal. concrete reservoir, at $20,000.

Va., Charlottesville—W. T. Thurston & Co., Merchants National Bank Bldg., Richmond, awarded contract for 2,000,000-gal. rein. conc. filter, 1,000,000-gal. rein. conc. reservoir, 5,000-ft. 16-in. concrete pipe, etc., at $130,000.

Wash., Walla Walla—Williamette Iron Works, Portland, Ore., awarded contract for furnishing 11,250 ft. 24-in. steel water pipe with 5-16-in. wall, at $50,062. Pipe will be used in extending city's water supply system.

Prospective Work

ROADS AND STREETS

Ariz., Nogales—Work on new 1,000-mile Mexico Hwy., will start in March, according to Gen. Angel Flores.

Ark., Batesville—Contract will be let about Mch. 15, for road work (native gravel) in No. Ark. Impvt. Dist. No. 2, of Independence, Izard and Fulton counties. Work will be let in 4 sections, 20 miles each. Plans call for conc. and steel bridges. Est. cost $600,000. E. C. Parsons, Batesville, Chrmn. Board of Commrs., E. E. Mashburn, Cotton Plant, Engr.

Cal., Glendale—About 50 street impvts. coming up in Glendale. City Engr. C. L. Hill states that two or three will be advertised for bids each week until program is completed. Many are good sized jobs.

Cal., Huntington Pk.—City Engr. H. McCurdy, Pacific Elec. Bldg., Los Angeles, instructed by City Trustees to prepare plans and specfs. for paving Randolph St., east to west city limits, a little over a mile, with 6-in. asph. concrete.

Cal., Merced—J. F. McSwain, former City Engr. of Merced, preparing plans and specfs. for about 20 to 22 miles oil macadam pavement, 5 to 6 ins. thick, to be built on roads leading from back country to Livingston and Atwater on state hwy. in northern part of Merced Co. Work will be done under Rd. Dist. Impvt. Act of 1907. Cost about $250,000. Plans completed in about 45 days.

Cal., Pomona—Proceedings being started and bids will be received some time in April for improving 7 streets, involving about 473,442 sq. ft. 5-in. conc. pavement and 6,600 lin. ft. cem. curb. F. C. Froehide, City Engr.

Cal., Sacramento—Chrmn. N. R. Darlington, of the Calif. Hwy. Comn., announces that plans of Comn. call for impvt. of Pacific Hwy. from Dunsmuir, Cal., to Oregon state line, at cost of more than a million dollars. Section from Dunsmuir to Weed, 21 miles, has been graded and will be paved throughout this present year; section from Weed to Gazelle, 11 miles, will be partly graded and surfaced and whole will be graded in near future. Bet. Gazelle and Yreka road has not been improved (18 miles), but Comn. is considering expendt. of $200,000 on it. From Yreka to Ore. line, 25 miles, Comn. has graded and graveled and that portion bet. Klamath River and Ore. line will be widened and paved at cost of $250,000.

Conn., Bridgeport—Streets and Sidewalk Corn., plans to expend $200,000 for general and special grading work. J. A. McElroy, City Engr.

Conn., Manchester—City contemplates paving Main St.—Charter Oak to Center Sts.—concs., $100,000. J. F. Bowen, Town Hall, Engr.

Fla., Clearwater—Pinellas Co. contemplates issuance of $1,000,000 bonds for widening present brick paved roads.

Fla., Tavares—$600,000 bonds have been sold. Proceeds will be used for constr. of 70 miles of sand clay rds. and rebldg. of 50 miles old roads of Districts Nos. 3, 4 and 5, in this county. This will include rd. from Astor to Polk Co. line, via Umatalla, Eustis, Tavares, Clermont and So. Clermont, thence to Groveland to Auburndale. Rd. will also be built from Eustis east through Paisley to the St. John's River; one along shores of Lakes Dora and Eustis; also lake drive around north shore of Lake Mineola to Clermont.

Ida., Boise—More than $2,200,000 will be expended by state in Northern Idaho, according to announcement made by Commr. W. J. Hall. Arrangements completed to finish 4 miles north and south hwy. just north of Sandpoint. State also making survey of Laclede Hill bet. Sandpoint and 4 miles of this will be built this summer by county under state specifications and supervision. On No. Pacific Rd., Lookout sect., National Mill above Mullan to Mont. line (5 mi.), will be completed.

Ill., Belleville—Tentative plans for 5 hard road projects in St. Clair Co., Ill., announced by D. O. Thomas, Supt. of Hwys.: Approx. cost of high-

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Bruces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors. Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

ways, $25,000, $100,000, $140,000, $180,000 and $420,000.

Ill., Brookfield—Will open bids about April for paving various streets here; rein. conc., $20,000. E. Hancock, 2047 Ogden Ave., Chicago, Cons. Engr.

Ill., Chicago—Bd. Local Impvts., 207 City Hall, considering paving Western Ave., 71st to 95th Sts., $495,001; from 95th to 111th Sts., $331,000; 111th to 119th Sts., $142,000. Will also take bids in near future for widening Western Ave.; Lawrence Ave. to W. 31st St. C. D. Hill, Chief Engr.

Ill., Joliet—Will County making plans for conc. paving on various roads, $91,500. W. H. Smith, Court House, Engr.

Ia., Charles City—Plans to pave 6-mile road in Floyd Co. Engr., G. Elhott, Co. Aud. T. B. Russell. $150,000.

Kans., Hutchinson—25 miles gravel rd. will be built across Pawnee Co., Larned to Burdett. Ests. of cost indicate road will cost about $125,000. Fed. and State Aid.

Kans., Topeka—State Hwy. Comn. placed $1,428,112 in balance against unemployment in state by granting that amt. of fed. aid for hwy. constr. This means a total of $2,856,225 will be expended at once on road constr. in Kansas. Total mileage of hard surfaced rds. projected in aid granted, is 116.4 miles. This includes 7 large bridges and 1,100 ft. trestle work. Shawnee Co. receives $180,000 in Fed. aid for use immediately in constr. of 15 mi. hard surfacing (probably concrete.)

Ky., Louisville—City will soon ask bids for rebldg. and asph. paving on portions of 7th, 8th, 18th, Portland, 28th, Finzer, Baxter, Fehr and Hill Sts., $130,000. A. A. Krieger, City Engr.

La., New Orleans—Commission Council adopted tentative paving program for 1922, which if carried out, will call for expendt. of $500,000 on part of city and $2,200,000 of prop. owners' money. Ord. introduced by Pub. Prop. Commr. Wilbert Black calls for new paving on 21 streets and repaving sections of 6 additional ones.

La., New Roads—Pointe Coupee Parish (J. A. Oubre, Secy.), will sell $73,000 Road Dist. No. 6; $64,500 Rd. Dist. No. 1, $115,000 Rd. Dist. No. 2 and $47,500 Rd. Dist. No. 4, road construction bonds.

Mass., N. Attleboro—Constr. of approx. 80 miles state hwy. to cost in neighborhood of $2,500,000, is proposed during 1922 by State Dept. of Public Works, Boston Dept., will undertake reconstr. of 2 sects. of Providence-Boston route. In Norwood it is planned to build a little more than a mile of high class concrete road from Westwood line southerly to Norwood. In Walpole, Norfolk and Wrentham, about 6½ mi. also of concrete, will be constructed from Walpole line southerly to Wrentham.

Mich., Benton Harbor—City will pave Empire Ave. W. and E. Main, Territorial, Fair Aves. and several other streets. Opening of Wall St. estimated to cost $100,000, will in all probability be carried out.

Mich., Detroit—Wayne County expects to lay 50 miles of highway, work to start in spring. Concrete surface at cost of $2,000,000. Replacement of dilapidated bridges will cost $1,000,000.

Mich., St. Ignace (Mackinac Co.)—State Hwy. Comn. plans approx. 225 miles new rd. constr. in 1922 in Mackinac, Schoolcraft and Chippewa Cos. H. I. Davis, Escanaba, Dist. Hwy. Commr., F. F. Rogers, St. Hwy. Commr., Lansing. Est. cost, $2,300,000.

Minn., St. Paul—Constr. of the $250,000 hwy. to South St. Paul and territory to south is virtually assured. Ord. passed to pave connecting link within city limits. Bd. Co. Commrs. have included, in this year's paving fund money to assist So. St. Paul with continuation of paving and also to build new road of 6 miles into Rich Valley. Bd. also passed by Council calls for paving State St., Oakland Ave. to S. Robert Sts.; S. Robert St.; Gates to south city limits. Est. cost of paving, which is to be brick laid flat, is $47,432.

Mo., Jefferson City—State Hwy. Comn. has approved plans on about 250 miles hwy. representing expendt. of more than $2,000,000, according to information from state hwy. dept. St. Bd. approved state aid projects, begun by former Comn., representing 54.49 miles of hyw. at cost of $272,468, snf. approved for constr. 55.86 mi. state aid projects at cost of $348,883. Fed. aid proj. approved total 136.69 miles at cost of $1,388,875.

Mont., Great Falls—Will gravel surface 15 miles of road from Sun River through Fort Shaw, Simms to Knox Hill. Engr. E. T. Harlow, St. Hwy. Comn. Jesse R. Bennett, Co. Commr., Cascade Co., $112,000.

Neb., Omaha—Expendt. of more than $1,000,000 for paving 29 3-20 miles rural rds. in Douglas Co., during 1922, recommended to Bd. Co. Commrs. by joint good roads committee. Program proposed includes impvt. of portions of Lincoln Hwy., Center Street Rd., 6th St. Rd., Military Hwy., Briggs Rd. and West O St. Rd.

Nev., Reno—Paving of city streets decided upon by City Council. Will approximate 759,448 sq. ft. Twp. types asph. conc. pavement will be laid. Est. cost $197,056. Harry Chism, City Engr.

N. J., Trenton—Bd. of Freeholders, Mercer Co., plans reconstructing 1.9 mi. White Horse-Yardville Rd., $100,000; 0.2 mi. E. Clinton Ave., $15,000; 0.7 mi. So. Broad St., both sides, $110,000; 1 mi. River Rd., $36,000 and 0.09 mi. River Rd., Washington Crossing, $50,000. H. F. Harris, Engr., Court House. Board also contemplates paving 1½ miles River Rd. at Scudders' Falls (concrete), $80,000.

N. C., Bryson City—Commrs. Forney Twp. plan to grade and surface 25 miles road from here to Tenn. line, $400,000. T. H. Hunter, Chmn. Twp. Comn.

O., Cincinnati—Hamilton County had plans prepared for impvt. of Clough Rd., Batavia pike to $13,500 ft. eastwardly, 8,700 cu. yds. earth embankment, 895 sq. yds. bitum. conc., 24,410 sq. yds., 1-1½-3 conc. and 26,000 cu. yds. gravel foundation. $129,115. E. A. Gast, Court House, Engr.

O., Elyria—Cleveland-Elyria Rd. will be improved for 12 miles at cost of $160,000.

Okla., Dawson—Tulsa Co. Commrs. will invite bids for constructing road. $250,000 bonds sold.

Okla., Duncan—City will pave approx. 30 additional blocks in resident district. Benham & Mullergren, Kansas City, Mo., Cons. Engrs. Est. cost of work $250,000.

Okla., Oklahoma City—Following work planned for 1922: Chart just completed shows that Cleveland and McClain Cos. have rd. proj. under consideration which has been delayed by litigation, of an est. cost of $200,000; Bryan Co. has proj. est. at $240,094, with Fed. aid of $111,839, which is 20 per cent completed; Ottawa Co. has proj. est. at $345,304, of which $164,155 was Fed. aid funds. It is 89.1 per cent completed. Tulsa Co. has projects est. at $2,170,817, which is 65.8 per cent completed, and it has received Fed. aid of $680,000; Washington County's proj. amounting to $514,769, is 53.6 per cent complete and Fed. aid of $250,000 has been obtained; Okla. Co. projects have totaled $711,423 and Fed. aid of $283,114 obtained. Its project is 93 per cent completed; McCurtain Co. has pending proj. of $790,410 for which it is to receive $362,736. Bryan Co. has done one-tenth of work on its rd. program, est. at $966,184, of which $480,892 was Fed. aid. Work has not started on projects in Okmulgee Co., est. at $944,854, of which $250,000 was to be Fed. aid, or in Muskogee or Haskell Cos., where $622,200 is to be expended with Fed. aid of $278,497, etc.

Okla., Okmulgee—City officials expect to get the 8th St. paving job under way by first of March. Part of the work has started at cost of $55,000. Entire project will cost over $150,000.

Okla., Poteau—Leflore Co. will pave hwy. across entire county. Voted $800,000 bonds.

Ore., Eugene—More than $800,000 in sight at present time for new rd. constr. and impvts. in Lane Co.

Pa., Harrisburg—Agreement on constr. of hwys. of importance to interstate travel, on which U. S. Govt. will furnish financial aid, reached by hwy. engineers of Pennsylvania, New York, New Jersey and the Government. Roads to be built will connect Phila. and Trenton, Easton and Philipsburg, Eastward, Portland, Penn., eastward and eastward from Columbia, N. J.; through Erie Co.; Warren and Jamestown; Bradford, Northward passing, westward to Olean; Mansfield to Elmira, Towando to Waverly, Stroudsburg to Port Jarvis and Scranton to Binghampton.

S. C., Greenwood—City will pave streets at cost

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Reeter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

of $200,000. Tomlinson Engrg. Co., Engrs., Columbia.

Tex., Dallas—Following decision to sell the $1,250,000 street bonds the City Comn. was preparing to resume impvt. activities. Projects totaling approx. $500,000 in paving, storm sewers and street widening will be launched.

Tex., Palo Pinto—Palo Pinto Co. will constr. 42 miles Hwy. No. 1 through county; cost about $1,400,000. E. L. Pitts, Co. Judge; G. W. Courter, Cons. Engr., Marlin, Tex.

Wash., Seattle—Expendt. of approx. $550,000 for impvt. of county hwys. during 1922 is contemplated, according to announcement made by Co. Engr. Thos. R. Beeman. Principal projects planned are: Completion of paving of hwy. around Lake Washington by paving 3¾ mi. bet. Bellevue and Newport, at $112,500; 5 miles on Sunset Hwy. from Issaquah to Preston, $75,000 from King Co. and like amt. from Fed. Govt.; tearing up 5-mile Kent-Orillia Hwy. and laying of conc., $150,000; grading and graveling mile and a half east valley rd. from Auburn so. to Pierce Co. boundary, $20,000, etc.

Wash., Spokane—U. S. Dept. of Interior is planning constr. of 34 miles new highway, costing $320,000, during 1922 in national parks. G. E. Gooding, Washington, D. C., Chief Engr. of National Parks Service. One of the most important projects will be the constr. of connecting link bet. east and west sides of Glacier National Pk.

Wis., Chippewa Falls—Chippewa Co. Commrs. may purchase patrol graders, scarifiers, plows, tools, etc., for county road work. Special meeting March 15. P. O. Lokrantz, Co. Hwy. Commr.

Wis., Hudson—St. Croix Co. will probably purchase additional truck bank sloping attachment for grader and wheelers and slips. Poe Caffrey, Co. Hwy. Commr.

Wis., Juneau—Will advertise bids for paving abt. 35 miles 18-ft. concrete road and about 20 miles 16-ft. gravel surface. Survey made. Also small bridges. Div. Engr., A. L. Hambrecht, Madison; Hwy. Commr., E. T. Klug, Juneau, $1,100,000.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Los Angeles—Ord. passed by Council and bids will be issued soon for constr. of Arroyo de la Secatella storm sewer, estimated to cost $2,500,000. Contractors will be given about 60 days to figure the work. Dist. embraces about 16 sq. miles in Hollywood and western part of city. Main lines, not including connects. to catch basins, will total about 80,678.71 ft., part of which will be monolithic reinf. conc. and part reinf. conc. pipe. In addn. to constructing drains and catch basins there will be a large amt. of paving, curb and sidewalk work in the nature of repairs.

Cal., Richmond—San Pablo San. Dist. will take bids about March 1, for constr. of 570 lin. ft. 6-in., 1,070 lin. ft. 8-in., 2,200 lin. ft. 10-in., 4,600 lin. ft. 15-in., 1,429 lin. ft. 21-in., and 5,250 lin ft. 24-in. vit. sewers, etc. R. L. Calfe, 221 S. 2nd St., Engr.

Ill., Glen Ellyn—Plans being prepared for 2 miles of 8-10 in. vitr. tile san. sewers in College Hill Addn., $30,000. G. G. Nelson, Sherwin Bldg., Elgin, Engr.

Ky., Paducah—Designs for approx. $600,000 worth of trunk line sewers here are under way; bids to be received, probably, before June 1st. Henry A. Pulliam, Commr., Public Works and City Engr.

Mich., Kalamazoo—Having prelim. plans made for sewer extensions, vitr. crock and brick, or conc., $100,000. E. S. Clark, City Engr.

Mich., River Rouge—It is planned to constr. 2 miles main outlet sewers, 4-6 ft. diam., depth of cut 10 ft., $100,000. G. Jerome, 1331 Majestic Bldg., Detroit, Engr.

Minn., Minneapolis—City Council has approved recommendations by Comm. on Sewers for emergency constr. to cost $337,000. Purchasing Agt. directed to obtain bids for material for work. Following projects recommended: Lateral sewer on Universal Ave., 12th to 13th Sts., $2,750; main sewer on 31st Ave., northeast from 5th to Central, $10,000; Main sewer on 42nd Ave., Washburn to Thomas and on Washburn from 38th to 42nd, $66,120; Linden Hills Dist. sewer, $65,520, and Minnehaha Creek sewer tunnel, $75,000.

Neb., Omaha—City will build 4 large sewer projects this year. Includes 800 ft. to Minne Lusa sewer; Saddle Crk. sewer from Poppleton Ave. and 15th Ave. to Center; Spring Lake Park to 13th and J Sts.; W. from Ft. Omaha at 37th and Redmond, 15 miles. C. F. Bossie, City Clerk, $500,000.

N. M., Albuquerque—City Engr. Kimball recommends following impvts.: Sewage disposal plant, $115,000; extens. to san. sewer, $50,000; storm sewer extensions, $95,000; new reservoir with pumps and additional pipe line, $50,000.

N. Y., Rochester—Com. Council passed Ord., providing for $377,000 for new storm water outlet sewer, known as Goodman Street and Webster Ave. outlet sewer.

O., Bexley (Columbus P. O.)—Plans about 2 mi. and 8 and 10-in. sewers, $85,000. Jennings-Lawrence Co., Hartman Bldg., Columbus, probably engrs.

Ore., Pendleton—Engrg. work for city's septic tank will be done by Maar and Cunningham, Cons. Engrs., Portland. Dept. Public Wks. will constr. Lents truck sewer at est. cost of $750,000.

Tex., El Paso—City will extend sewer system; voted $250,000 bonds; also install sewage disposal plant; voted $125,000 bonds. Chas. Davis, Mayor.

Wash., Aberdeen—Constr. of 2 trunk sewers, one in South and the other in West Aberdeen, authorized by City Council.

Wis., Milwaukee—Survey being made for sewers to drain Milwaukee Co. About 22,000 ft., 30 to 48 ins. conc. pipe, 400 ft., 20 ins. cast iron pipe. T. C. Hatton, Engr., City Hall; Metropolitan Sewerage Comn., 221 Grand Ave., making survey, $3,000,000.

WATER SUPPLY AND PURIFICATION.

Cal., Monterey Park—$225,000 bond issue carried for municipal water system. Olmsted & Gillelen, Hollingsworth Bldg., Los Angeles, Cons. Engrs.

Cal., Sacramento—$500,000 bonds voted here by citizens for completion of filtration plant; also $200,000 for waterfront impvts.

Cal., San Diego—Hydr. Engr. H. N. Savage has recommended to Council immediate constr. of dam at Mission Gorge,; est. cost $3,250,000, including filter plant and conduit to city at 11th St. and So. side Balboa Pk. He proposes gravity type masonry dam 116 ft. high impounding 87,000 ac. ft. water. He estimates cost of dam at El Capitan site at $4,500,000. East San Diego—City Engr. E. Paul Ford, has been instructed to prepare plans and ests. of cost for complete municipal water distributing sys. which will require some 30 miles of pipe and a large number of fire hydrants.

Ont., Windsor—Border Cities Utilities Comn., having plans prepared by J. K. Keith, Engr., 1246 Howard Ave., for joint filtr. plant and reservoir to supply Windsor, Walkerville, Ford, Sandwich and Ojibway. $1,000,000.

Conn., Kensington—Fire Dept., making plans for extension of water supply system, $100,000. L. A. Oldershow, 150 Main St., New Britain, Engr. D. F. Crowley, 255 Main St., Bristol, Assoc. Engr.

Ia., Muscatine—City will make impvts. at water works plant this summer which will cost about $50,000. Wk. includes laying 16 or 20-in. main from pump plant on Island to Grandview Ave., and new pumps. Wm. Molis, Supt., Water Dept.

Minn., Minneapolis—City plans 2 miles 24-in. mains from Mt. Curve and Humboldt Aves. to Lake Calhoun and Linden Hills Dist., at cost of $128,000; brick water tower in northeast section, at $37,000. W. N. Elsberg, Engr. Work will be done by day labor.

N. J., Camden—Impvts. in facilities of N. J. Water Service Co., serving Camden Co., ordered by Public Utility Comn., calling for new standpipe, mains in all streets of Audubon, Oaklyn and Barrington, also completion of distribution system in Barrington.

O., Newark—Plans being made and bids will be asked about April 1st for filtr. and softening plant, 6,000,000-gal. daily capy., $225,000. C. P. Hoover, 186 W. Spring St., Columbus, Engr.

Tex., Paris—City will expend $1,000,000 to install water works; plans constructing 3,000,000-gal. capy. purification and pumping plant, including earth and conc. dam; 4½-mile, 18 or 20-ft. cast iron pipe line; 4,000,000-gal. capy. elevated steel tank. Jno. B. Hawley, Cons. Engr., Calton Exchange Bldg., Ft. Worth, Tex. Plans extending cast iron pipe distribution system.

BUYERS' GUIDE

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.
Littleford Brothers.

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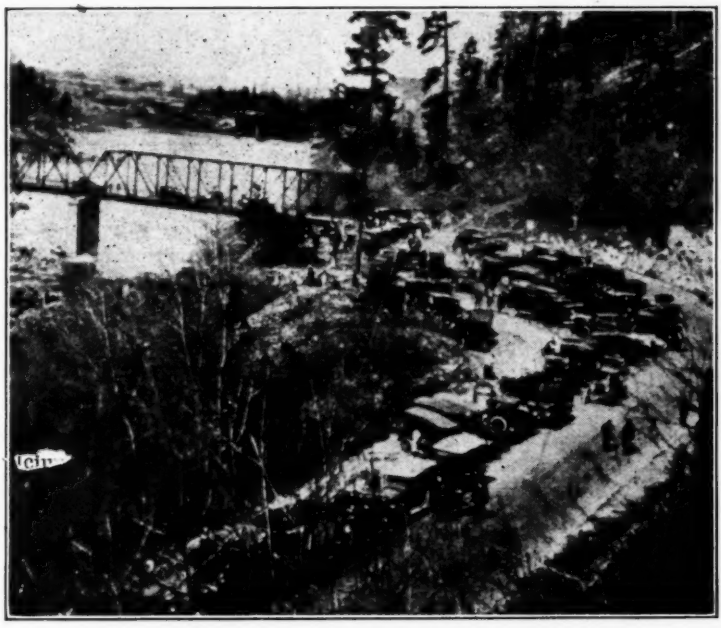

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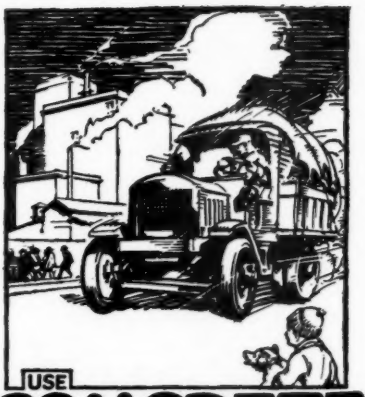

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